



SPRING-8/SACLA Research Frontiers 2022

CONTENTS



Preface	5
Editor's Note	6
Scientific Frontiers	7
Reviews	
Formation and evolution of the C-type asteroid 162173 Ryugu: Evidence from returned samples analyzed by X-ray micro- and nano-tomographies <i>A. Tsuchiyama and M. Matsumoto</i>	8
Extracting order within disorder in disordered materials by high-energy X-ray diffraction <i>S. Kohara</i>	12
Life Science	
Protein Crystallography: Crystal and cryo-EM structures of the gastric proton pump bound with potassium-competitive acid blockers <i>K. Abe</i>	16
Protein Crystallography: Structural basis for substrate discrimination and accommodation in bacterial site-2 protease homologue RseP <i>Y. Imaizumi, K. Takanuki and T. Nogi</i>	18
Protein Crystallography: Crystal structure of the small-molecule-bound apelin receptor <i>Y. Yue and F. Xu</i>	20
Protein Crystallography: Structural basis for neutralization of SARS-CoV-2 Omicron variant using engineered ACE2 decoy <i>T. Arimori and J. Takagi</i>	22
Protein Crystallography: Cell-free protein crystallization for structural analysis <i>S. Abe and T. Ueno</i>	24
Protein Crystallography: Master allostery in clock protein KaiC orchestrates circadian rhythm <i>Y. Furuike, A. Mukaiyama and S. Akiyama</i>	26
Protein Crystallography: Time-resolved X-ray crystallography of enzymatic reaction that degrades a mutagenic nucleotide <i>T. Nakamura</i>	28
 Protein Crystallography: Flavin photoreduction mechanism in a DNA photolyase elucidated by time-resolved X-ray crystallography <i>Y. Bessho, M. Maestre-Reyna, L.-O. Essen and M.-D. Tsai</i>	30
Intact Human Skin Structure: Lipid structure in stratum corneum of human skin <i>N. Yagi, K. Aoyama and N. Ohta</i>	32
Eye lens: Water channel proteins and their role in lens optics and cataract <i>B. K. Pierscionek, K. Wang and M. Hoshino</i>	34
Nuclear Resonance Spectroscopy: Nuclear resonance vibrational spectroscopy definition of intermediate Q in methane monooxygenase <i>D. E. DeWeese, A. Braun and E. I. Solomon</i>	36
Paleontology: Unveiling an enigmatic fossil vertebrate from the Middle Devonian <i>T. Hirasawa</i>	38

Physical Science

Thermoelectric Material: MEM electron density and 3D- Δ PDF study of disorder in thermoelectric InTe <i>J. Zhang, E. Nishibori and B. B. Iversen</i>	40
Phonon Softening: Experimental determination of electron states with orbital degrees of freedom <i>T. Manjo and H. Sawa</i>	42
Grain Boundary Tracking: Multimodal assessment of mechanically induced transformation in TRIP steel using X-ray micro- and nano-CT and pencil-beam XRD-CT <i>H. Toda and H. Fujihara</i>	44
Nondestructive Visualization: Nondestructive visualization of inhomogeneous structure inside 40–500 nm single particles using Bragg coherent X-ray diffraction and phase retrieval analysis <i>N. Oshime</i>	46
Stress Measurements: Stress measurements of coarse-grained materials and welded parts by double exposure method with high-energy monochromatic X-rays <i>K. Suzuki</i>	48
Strange Metal: Critical slowing down in charge fluctuation in a strange metal probed by synchrotron radiation-based Mössbauer spectroscopy <i>H. Kobayashi</i>	50
SiO₂ Liquid: Structural origin of the anomalous properties of SiO ₂ glass under pressure revealed by <i>in situ</i> high-pressure pair distribution function measurement <i>Y. Kono</i>	52
Hematite Mesocrystal: Local structures of hematite-mesocrystal-based photoanodes for efficient and selective solar water splitting <i>T. Tachikawa</i>	54
Fermi Surface in Cuprate Superconductors: X-ray Compton scattering reveals electronic motions with a preferred direction in high-temperature cuprate superconductors <i>H. Yamase</i>	56
Superconducting Material: Effect of impurities on superconductivity in LaH ₁₀ <i>D. Semenov</i>	58
Magnetic Domain Imaging: Three-dimensional visualization of magnetization reversal behavior inside a high-performance Nd–Fe–B permanent magnet <i>M. Suzuki and S. Okamoto</i>	60
Skyrmion Visualization: Direct visualization of three-dimensional shape of magnetic skyrmion string <i>S. Seki</i>	62
Next-generation Magnets: Magnetic moments of Fe site in ThMn ₁₂ -type Sm(Fe _{1-x} Co _x) ₁₂ compounds and their temperature dependence <i>Y. K. Takahashi</i>	64
 Ultrahigh Magnetic Field for XFEL: Road to X-ray science beyond 100 Tesla <i>A. Ikeda and Y. H. Matsuda</i>	66
Ptychography Optics: Coherent achromatic rotational reflective optics for ptychography (CARROT) at SPRING-8 BL07LSU <i>T. Kimura and Y. Takeo</i>	68

	Organic Semiconductor: Phonon dispersion curve of the organic semiconductor rubrene <i>Y. Wakabayashi</i>	70
	Radiation Induced Deformation: Direct observation of local structure deformation induced by X-ray irradiation in κ -(BEDT-TTF) ₂ Cu[N(CN) ₂]Br by X-ray fluorescence holography <i>A. K. R. Ang</i>	72
	X-ray Laser Science: Generation of femtosecond X-ray pulse pairs <i>U. Bergmann</i>	74
	Curing Mechanism of Epoxy: Evaluation of dynamical behavior of epoxy resins in the curing process by X-ray photon correlation spectroscopy <i>T. Hoshino, Y. Okamoto and A. Yamamoto</i>	76
	Dynamics of Helical Polymers: Kinetics of denaturation and renaturation processes of double-stranded helical polysaccharide, xanthan, in aqueous sodium chloride <i>K. Terao and Y. Tomofuji</i>	78
	Laser-plasma Physics: Nanoscale subsurface plasma dynamics observed by single pulse GISAXS <i>L. Randolph, M. Banjafar, C. Gutt and M. Nakatsutsumi</i>	80

Chemical Science

	High-entropy Alloy: Formation mechanism of high-entropy alloy nanoparticles assisted by hydrogen spillover effect <i>K. Mori, N. Hashimoto and H. Yamashita</i>	82
	Microcrystalline Materials: Chemical crystallography by serial femtosecond X-ray diffraction: XFEL as a tool for accelerating materials discovery <i>J. N. Hohman and A. S. Brewster</i>	84
	X-ray Laser Imaging: Intact sea-island nanostructures of solid-state electrolytes snapshotted with a femtosecond X-ray laser <i>A. Suzuki and Y. Nishino</i>	86
	Hydrogen Storage Metals: Hydrogen storage by earth abundant metals – high-pressure synthesis of Al ₃ FeH ₄ <i>H. Saitoh</i>	88
	Spin Tube Oxide: Spin tube oxide obtained by topochemical dehydration <i>H. Takatsu, H.-B. Li and H. Kageyama</i>	90
	Proton Conduction: Phonon-assisted proton(deuteron) transfers leading the antiferro-electric ordering in superprotonic conductors Cs ₃ H(D)(SeO ₄) ₂ <i>H. Matsui</i>	92
	Operando HAXPES: Unraveling the resistive switching mechanisms in LaMnO _{3+δ} -based memristive devices by <i>operando</i> hard X-ray photoemission <i>B. Meunier, E. Martínez and O. Renault</i>	94
	Layered Rare-earth Hydroxide: Observation of rapid lift-up behavior of acetate-intercalated layered yttrium hydroxide interlayer in water: Application for heterogeneous Brønsted base catalysts <i>T. Hara and N. Ichikuni</i>	96

Earth & Planetary Science

Earthquake Mechanism: <i>In situ</i> X-ray and acoustic observations of deep seismic faulting upon phase transitions in mantle olivine <i>T. Ohuchi</i>	98
Mantle Viscosity: Viscosity measurements of bridgmanite by <i>in situ</i> stress and strain observations <i>N. Tsujino</i>	100
EOS of Iron: Equation of state of iron and nickel to 370 gigapascals <i>N. Hirao and Y. Akahama</i>	102
Chemistry of Earth's Core: Stratification in planetary cores by liquid immiscibility in Fe–S–H <i>S. Yokoo</i>	104
Elasticity of Earth's Core: Sound velocity of hexagonal close-packed iron to the Earth's inner core pressure <i>D. Ikuta, E. Ohtani and A. Q. R. Baron</i>	106

Industrial Applications

Li-ion Battery: <i>Operando</i> X-ray diffraction and X-ray absorption spectroscopy of zero-strain lithium-ion battery material $\text{Li}[\text{Li}_{1/3}\text{Ti}_{5/3}]\text{O}_4$ <i>K. Mukai, T. Uyama and T. Nonaka</i>	108
---	-----

Accelerators & Beamlines Frontiers 110

SPRING-8

Beam Performance - Recent update on accelerators	111
---	-----

SACLA

Beam Performance - Recent update on accelerators	112
---	-----

New Apparatus, Upgrades & Methodology

• High-fluence multilayer focusing optics attaining 2 nm spatial resolution in XFEL based coherent diffractive imaging <i>H. Yumoto</i>	114
--	-----

Facility Status 116

SPRING-8

Introduction	117
Machine Operation	118
Beamlines	119
User Program and Statistics	122
Research Outcome	125
Research Complex	125
SPRING-8 Users Community (SPRUC)	128
Outreach Activities	129

SACLA

Machine Operation & Beamlines	130
User Program and Statistics	130

SPRING-8/SACLA

Budget and Personnel	131
----------------------	-----

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