Bulletin of the Polish Synchrotron Radiation Society

SYNCHROTRON RADIATION IN NATURAL SCIENCE

Vol. 27, 2026

Joint Meeting of Polish Synchrotron Radiation Society Members and SOLARIS Centre Users

14-16 SEP. 2026

polish synchrotron radiation society

ISSN 3072-5321

Polish Synchrotron Radiation Society Location:

Location: ul. Radzikowskiego 152
31 – 342 Kraków

Society Board
(2023 – 2027)

Chairman:
Dr hab. inż. Agnieszka Witkowska
Institute of Nanotechnology and Materials Engineering
Gdańsk University of Technology, Gdańsk

Vice-chairman:
Dr hab. inż. Edyta Piskorska-Hommel
Institute of Low Temperature and Structure Research PAS, Wrocław

Vice-chairman:
Prof. dr hab. inż. Marcin Sikora
SOLARIS National Synchrotron Radiation Centre,
Jagiellonian University, Kraków

Secretary:
Dr hab. inż. Anna Wolska
Institute of Physics PAS,
Warszawa

Treasurer:
Dr hab. inż. Joanna Czapla-Masztafiak
Institute of Nuclear Physics PAS,
Kraków

Members:

Prof. dr hab. Marek Stankiewicz
SOLARIS National Synchrotron Radiation Centre,
Jagiellonian University, Kraków

Prof. dr hab. Maciej Kozak
SOLARIS National Synchrotron Radiation Centre,
Jagiellonian University, Kraków
Adam Mickiewicz University, Poznan

Prof. dr hab. Wojciech M. Kwiatek
Institute of Nuclear Physics PAS,
Kraków

Dr hab. inż. Ryszard Sobierajski
Institute of Physics PAS,
Warszawa

Prof. dr hab. Paweł Korecki,
SOLARIS National Synchrotron Radiation Centre,
Jagiellonian University, Kraków

Dr hab. Marcin Klepka
Institute of Physics PAS,
Warszawa

SYNCHROTRON RADIATION IN NATURAL SCIENCE

Editor-In-Chief

Editorial board

Cover designed by Kamila Nowak

Preface

The Joint Meeting of PSRS Members and SOLARIS Centre Users (JMSU) has become an important event for the Polish and international community of researchers using synchrotron radiation and other large-scale research infrastructures. The meeting continues the long-standing tradition of the Symposium of Polish Synchrotron Users (KSUPS), organized between 1991 and 2017. Since 2020, this tradition has been continued in an expanded international format, bringing together members of the Polish Synchrotron Radiation Society, users of the SOLARIS Centre, and researchers working with synchrotron and cryogenic electron microscopy facilities.

The 2026 edition of JMSU is particularly special as it takes place in the year marking the 10th anniversary of the SOLARIS National Synchrotron Radiation Centre. The anniversary provides an opportunity not only to celebrate a decade of operation of Poland's first synchrotron light source, but also to reflect on the transformation of the Polish research landscape enabled by access to advanced large-scale research infrastructure.

Over the past decade, SOLARIS has become an important part of the European research infrastructure landscape. Its development has been accompanied by increasing international cooperation and the continuous expansion of its scientific capabilities. The 10th anniversary celebrated in May 2026 brought together representatives of Polish and European research infrastructures, scientific institutions and public authorities.

JMSU provides a natural forum for bringing together the community that has contributed to, and benefits from, the development of synchrotron-based research in Poland. The program reflects the highly interdisciplinary character of synchrotron research, encompassing areas ranging from structural biology, cryo-electron microscopy and biomedical research to materials chemistry, catalysis, energy-related research, nanotechnology, quantum materials, magnetism, surface science, geosciences and environmental studies.

The 2026 program also places particular emphasis on the broader European research infrastructure ecosystem. Presentations concerning access to facilities such as the European Synchrotron Radiation Facility (ESRF) and the European X-ray Free Electron Laser (European XFEL), as well as European user organizations and transnational access programs, underline the importance of international cooperation in contemporary experimental science.

A dedicated part of the meeting is devoted to CERIC-ERIC and the 10th anniversary of Polish membership in the consortium. The sessions provide an opportunity to review the research capabilities offered through CERIC and to present selected results obtained by Polish researchers with the support of this infrastructure.

We are pleased to present in this issue the *Synchrotron Radiation in Natural Science* abstracts contributed by the participants of the Joint Meeting of PSRS Members and SOLARIS Centre Users. We hope that this collection will provide a valuable overview of current research activities, encourage the exchange of ideas and experiences, and inspire new collaborations and scientific projects for the next decade of synchrotron research in Poland and beyond.

On behalf of the Editorial Team,
Edyta Piskorska-Hommel

CONTENTS

Joint Meeting of PSRS Members and SOLARIS Centre Users (JMSU)

14 -16 September 2026, Krakow, Poland

Chairs:

Marek Stankiewicz – SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, PSRS
Marcin Sikora – SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, PSRS

Program Committee

Artur Biela – SOLARIS National Synchrotron Radiation Centre, Jagiellonian University
Marcin Klepka – Institute of Physics Polish Academy of Sciences, PSRS
Paweł Korecki – Institute of Physics, Jagiellonian University, PSRS
Maciej Kozak – Institute of Physics, Adam Mickiewicz University and SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, PSRS
Wojciech Kwiatek – Institute of Nuclear Physics Polish Academy of Sciences, PSRS
Marcin Sikora – SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, PSRS
Ryszard Sobierajski – Institute of Physics Polish Academy of Sciences, PSRS
Marek Stankiewicz – SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, PSRS
Anna Wolska – Institute of Physics Polish Academy of Sciences, PSRS

Organizing Committee

Agnieszka Cudek, SOLARIS National Synchrotron Radiation Centre
Joanna Czapla-Masztafiak, Institute of Nuclear Physics Polish Academy of Sciences, PSRS
Oliwia Grabowska, SOLARIS National Synchrotron Radiation Centre
Ewa Partyka-Jankowska, SOLARIS National Synchrotron Radiation Centre
Edyta Piskorska-Hommel, Institute of Low Temperature and Structure Research Polish Academy of Sciences, PSRS
Katarzyna Tokarz, SOLARIS National Synchrotron Radiation Centre
Agnieszka Witkowska, Gdańsk University of Technology, PSRS
Barbara Wolanin, SOLARIS National Synchrotron Radiation Centre
Natalia Zapart, SOLARIS National Synchrotron Radiation Centre

Invited speakers

- **Beata Bochentyn** (Gdansk Tech), *Towards Understanding the Beneficial Impact of SOFC Anode Catalytic Layers through Complementary Studies at SOLARIS and ESRF*

- **Mariusz Czarnocki-Cieciura** (International Institute of Molecular and Cell Biology in Warsaw), *ATP-dependent DNA damage recognition by UvrA: The use of Cryo-EM in the study of protein conformational changes*

- **Keyron Hickman-Lewis** (Birkbeck University of London), *Exploring Earth's earliest ecosystems with synchrotron-based techniques: implications for the search for life on Mars*

- **Łukasz Kłopotowski** (Institute of Physics, PAS, Warsaw), *Mapping Out Element-Specific Carrier Relaxation Pathways in Double Perovskite Nanocrystals with Femtosecond X-ray Absorption*

- **Juraj Krempasky** (Paul Scherrer Institute, Villigen), *How* Ge, Mn and Te Changed My View of Magnetism (I-7)

- **Bartłomiaj Lemieszek** (Gdansk Tech), *Measurement Approaches In Solid Oxide Cell Technology: From Ex Situ To Operando Characterization*

- **Przemysław Nogły** (Jagiellonian University, Krakow), *From static structures to molecular movies: time-resolved serial crystallography of light-sensing receptors*

- **Michał Ślęzak** (AGH University of Kraków), *Studying low-dimensional antiferromagnets with synchrotron radiation*

Monday 14th September 2026

11:30-12:30 Tour of SOLARIS for those interested. Participation requires registration.
SOLARIS NSRC, ul. Czerowne Maki 98, Kraków

13:00 - 14:00 Registration and welcome lunch, Faculty of Chemistry Jagiellonian University

Session I – Information and support for synchrotron users (session chair: Marek Stankiewicz) (14:00 - 15:30)

Time	Title	Presenter
14:00	Polish Synchrotron Radiation Society – supporting the Polish photon-science community (O-01)	Agnieszka Witkowska
14:15	Update from SOLARIS Centre - accelerators, beamlines, cryo-electron microscopy facility (O-02)	Adriana Wawrzyniak Artur Biela Marcin Sikora
15:00	Support for Polish Users of EuXFEL (O-03)	Ryszard Sobierajski
15:15	New grant for Poland̓s participation in the ESRF (O-04)	Anna Wolska

15:30- 16:00 **Coffee break**

Session II - Cryo-microscopy and structural biology (session chair: Artur Biela) (16:00 - 17:30)

Time	Title	Presenter
16:00	ATP-dependent DNA damage recognition by UvrA: The use of Cryo-EM in the study of protein conformational changes (I-1)	Mariusz Czarnocki-Cieciura
16:30	Ribosomes at work: Visualizing translational dynamics directly in cells via cryo-electron tomography (O-05)	Magdalena Schacherl
16:50	Building beyond the icosahedron: novel virus-like particles and the structural basis of their assembly (O-06)	Joanna Śliwiak
17:10	The enigma of NIF3. structure without the function (O-07)	Elżbieta Wątor-Wilk

17:30 – 20:00 Poster session, Faculty of Chemistry Jagiellonian University

Tuesday 15th September 2026

Session III – Soft matter and biomedical research (session chair: Wojciech Kwiatek) (09:00 - 10:30)

Time	Title	Presenter
09:00	From static structures to molecular movies: time-resolved serial crystallography of light-sensing receptors (I-2)	Przemysław Nogły
09:30	CryoEM-Guided Engineering of Extracellular Vesicles for Regenerative Medicine and Precision Genome Editing (O-08)	Sylwia Bobis-Wozowicz
09:50	Capturing “Protein Spaghetti”: Biosaxs And Frap Analysis Of Phase-Separated Plant Cwc22 (O-09)	Marta Gapińska
10:10	Scientific capabilities of the s-SNOM/AFM-IR endstation (O-10)	Maciej Roman
10:30- 11:00 **Coffee break**		

Session IV – Materials chemistry and engineering (session chair: Marcin Klepka) (11:00 - 13:00)

Time	Title	Presenter
11:00	Measurement Approaches In Solid Oxide Cell Technology: From Ex Situ To Operando Characterization (I-3)	Bartłomiej Lemieszek
11:30	Structural divergence in ferrite-silica nanocomposites (O-11)	Adam Czempik
11:50	X-ray absorption spectroscopy investigation of pressure-driven spin crossover in a two-dimensional Hofmann clathrate (O-12)	Wojciech Sas
12:10	Enhancing the power density of a multinuclear Cobalt (II) cluster by the addition of a redox active electrolyte (O-13)	Javed Shah
12:30	Studying low-dimensional antiferromagnets with synchrotron radiation (I-4)	Michał Ślęzak
13:00 - 14:00 **Lunch**		

Tuesday 15th September 2026

Session V – Nanotechnology and quantum materials (session chair: Agnieszka Witkowska) (14:00 - 15:30)

Time	Title	Presenter
14:00	Mapping Out Element-Specific Carrier Relaxation Pathways in Double Perovskite Nanocrystals with Femtosecond X-ray Absorption (I-5)	Łukasz Kłopotowski
14:30	Mapping magneto-chemical heterogeneity in laser-synthesized bimodal colloids via synchrotron XAS and STXM (O-14)	Mohammad Sadegh Shakeri
14:50	Analysis of Ti and TiO2 nanolayers irradiated with HCI Xeq+ using SR-GIXRF and SR-XRR methods (O-15)	Regina Stachura
15:10	First demonstration of X-ray ptychography at the SOLARIS STXM (O-16)	Krzysztof Matlak

15:30- 16:00 **Coffee break**

Session VI – Geoscience, space science and applied research (session chair: Anna Wolska) (16:00 - 17:30)

Time	Title	Presenter
16:00	Exploring Earth's earliest ecosystems with synchrotron-based techniques: implications for the search for life on Mars (I-6)	Keyron Hickman-Lewis
16:30	Experimental validation of a CMOS-based Bragg crystal spectrometer at the SOLARIS synchrotron (O-17)	Żaneta Szaforz
16:50	Autonomous Sampling α-Fe2O3 Hollow Microspheres with Carbon-Stabilized Defects: Calcination-Tuned Humidity Sensor Performance (O-18)	Islam Gomaa
17:10	Neutron Activation Analysis Laboratory at NCPS Solaris (O-19)	Michał Silarski

19:00 –23:00 **Networking dinner, 3rd floor, Finestra Restauracja, Michała Bobrzyńskiego 10**

Wednesday 16th September 2026

Session VII – Research offer of CERIC-ERIC (session chair: Marcin Sikora)
(09:00 - 10:30)

Time	Title	Presenter
09:00	General presentation of CERIC-ERIC (O-20)	Ornela De Giacomo
09:20	Towards Elettra 2.0: new challenges and opportunities for Science at CERIC (O-21)	Lisa Vaccari
09:35	Small-Angle Scattering at TU Graz: Facilities and Scientific Highlights (O-22)	Heinz Amenitsch
09:50	NMR Spectroscopy in Structural Studies (O-23)	Janez Plavec
10:05	PPR@CERIC: An Integrated Research Infrastructure for Pathogen Research Including Advanced Genomics, Single-Cell Multi-Omics and Virology Unit (O-24)	Federica Mantovani
10:20	10 years of SOLARIS at CERIC-ERIC (O-25)	Marek Stankiewicz

10:30- 11:10 **Coffee break with anniversary cake**

Session VIII – CERIC supported research and featured talks (session chair: Ryszard Sobierajski)
(11:10 - 12:50)

Time	Title	Presenter
11:10	Towards Understanding the Beneficial Impact of SOFC Anode Catalytic Layers through Complementary Studies at SOLARIS and ESRF (I-7)	Beata Bochentyn
11:40	The Cecomec Project: Ceria-Based Compounds As Effective Catalyst For Electrochemical Cells (O-26)	Simone Amatori
12:00	AI-Driven Automation and Assistance at Synchrotron Facilities (O-27)	Maciej Jankowski
12:20	How Ge, Mn and Te Changed My View of Magnetism (I-8)	Juraj Krempasky

12:50 - 14:00 **Concluding remarks and goodbye lunch**

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ATP-DEPENDENT DNA DAMAGE RECOGNITION BY UVRA: THE USE OF CRYO-EM IN THE STUDY OF PROTEIN CONFORMATIONAL CHANGES

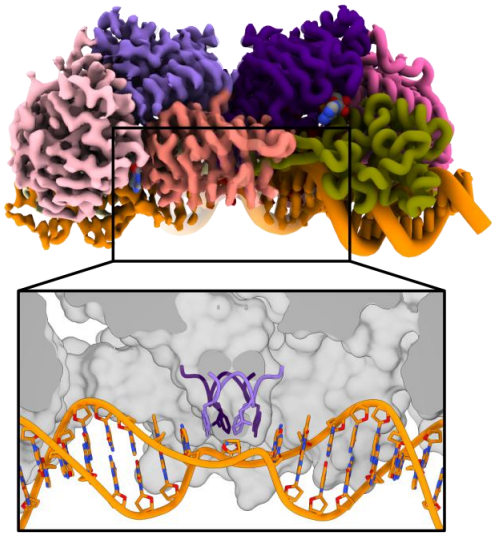
Mariusz Czarnocki-Cieciura[1,2,*], Shivlee Nirwal[1], Weronika Zajko[1], Krzysztof Skowronek[3], Roman H. Szczepanowski[3], Marcin Nowotny[1]

[1]*Laboratory of Protein Structure, International Institute of Molecular and Cell Biology in Warsaw (IIMCB), 02-109 Warsaw, Poland*

[2]*Preclinical Drug Development Facility, IN-MOL-CELL, IIMCB, 02-109 Warsaw, Poland*

[3]*Biophysics and Bioanalytics Facility, IN-MOL-CELL, IIMCB, 02-109 Warsaw, Poland*

**E-mail: mczarnocki-cieciura@iimcb.gov.pl*



Nucleotide excision repair (NER) is one of the fundamental pathways involved in the detection and repair of various DNA distorting lesions. In bacteria, NER involves four key proteins: UvrA, UvrB, UvrC, and UvrD. UvrA is a dimeric ATPase that detects the DNA damage and hands it over to UvrB – a weak helicase that verifies the presence of damage. UvrA then dissociates, and UvrC endonuclease is recruited. UvrC incises the DNA on both sides of lesion, and the excised fragment is removed by UvrD helicase. Finally, the resulting gap is filled by DNA polymerase I.

We used cryoelectron microscopy (cryo-EM) to study the role of the ATPase activity of UvrA in damage recognition. We determined a series of cryo-EM structures of UvrA in the presence and absence of nucleotides and in complex with three different DNA substrates. These structures allowed us to visualize a major rearrangement of the UvrA dimer upon ATP binding. These conformational changes are used to mechanically probe the integrity and deformability of DNA and indirectly detect the presence of DNA lesion. We also solved the cryo-EM structure of the UvrA:UvrB:DNA complex that sheds a light on how UvrB is loaded on the DNA for the verification of the presence of the lesion. Our structural findings are supported by complementary biochemical studies.

In summary, our series of cryo-EM structures presents snapshots of the mechanism of ATP-dependent DNA damage recognition by UvrA. It shows that mechanical probing can indirectly detect a broad range of DNA lesions and provides a framework for a deeper understanding of the bacterial NER pathway.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

FROM STATIC STRUCTURES TO MOLECULAR MOVIES: TIME-RESOLVED SERIAL CRYSTALLOGRAPHY OF LIGHT-SENSING RECEPTORS

Przemysław Nogły[1,*]

[1]*Dioscuri Centre for Structural Dynamics of Receptors, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, 30-387 Kraków, Poland*

**E-mail: przemyslaw.nogly@uj.edu.pl*

Static crystal structures have transformed our understanding of light-sensing proteins, yet they capture only snapshots of molecules that function through rapid, light-driven motions. Closing this gap means watching these proteins in action. Over the past decade, time-resolved serial crystallography — at X-ray free-electron lasers and, increasingly, at synchrotron sources such as MicroMAX — is used to follow photoreceptors and light-driven ion pumps across timescales from femtoseconds to milliseconds [1]. In this lecture I will trace our path from static models toward dynamic, mechanistic descriptions of these systems, illustrated with recent unpublished results on light-oxygen-voltage (LOV) domains, which are widely exploited as optogenetic tools. I will highlight the experimental and conceptual challenges of time-resolved measurements — sample delivery, reaction initiation, and reaching the relevant timescales — and show how complementary spectroscopy and computation strengthen the structural interpretation. Finally, I will discuss where time-resolved structural biology is heading, and the growing role of next-generation synchrotron beamlines in making molecular movies of biomolecules routine.

[1] Mous, S. et al. Structural dynamics of a chloride-pumping rhodopsin. Science 375, 845–851 (2022).

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

MEASUREMENT APPROACHES IN SOLID OXIDE CELL TECHNOLOGY: FROM EX SITU TO OPERANDO CHARACTERIZATION

Bartłomiej Lemieszek,[1,*] Alexey Maximenko[2], Lulu Alluhaibi,[2] Bartosz Kamecki,[1] Piotr Jasiński,[1] and Sebastian Molin[1]

[1] *Advanced Materials Centre, Faculty of Electronics, Telecommunications and Informatics, Gdańsk University of Technology, ul. G. Narutowicza 11/12, 80-233 Gdańsk, Poland*

[2] *National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Czerwone Maki 98, 30-392, Kraków, Poland*

**E-mail: bartlomiej.lemieszek@pg.edu.pl*

The development of low- and zero-emission technologies is a key area of modern energy technology and an essential component of the ongoing energy transformation. Among various fuel cells and electrolyzers technologies, high-temperature solid oxide cells (SOCs) are distinguished by their high overall and electrical efficiencies. Another important advantage of this technology is its high fuel flexibility. However, one of the main challenges limiting its wider commercialization is the high cost of materials and system components, which is largely associated with operation at elevated temperatures, typically in the range of 600–800°C. These demanding conditions require the use of expensive high-temperature-resistant materials, including high-chromium steels and other specialized components. Reducing the effective operating temperature of SOCs could extend their lifetime, improve long-term stability, and enable significant cost reductions. To achieve this, a deeper understanding of the structural, chemical, and electronic changes occurring in SOC materials under realistic operating conditions is required.

In this context, X-ray absorption fine structure spectroscopy (XAFS) can play a crucial role. XAFS is a powerful analytical technique that enables the investigation of local atomic structure and oxidation state changes in materials with high sensitivity. Importantly, it allows subtle material transformations to be monitored in real time, making it particularly valuable for studying processes occurring during cell operation. For this reason, the development of reliable operando XAFS measurement methodologies is crucial for advancing SOC research.

This study presents the process of developing in-situ / operando measurement procedures for high-temperature applications. Particular attention is given to the role and limitations of ex situ and in situ measurements, as well as to the experimental challenges associated with establishing a reliable methodology for operando characterization of SOC materials.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

STUDYING LOW-DIMENSIONAL ANTIFERROMAGNETS WITH SYNCHROTRON RADIATION

Michał Ślęzak,[1,*] Artur Kwiatkowski,[1] Edyta Oleś, Anna Kozioł-Rachwał,[1] Piotr Dróżdż,[1] Ewa Partyka-Jankowska,[2] Marcin Zając,[2] Marcin Szpytma,[2] and Tomasz Ślęzak[1]

[1] *AGH University of Krakow*

[2] *SOLARIS National Synchrotron Radiation Centre, Jagiellonian University*

**E-mail:* mislezak@agh.edu.pl

X-ray magnetic linear and circular dichroism (XMLD and XMCD) spectroscopy and photoemission electron microscopy (PEEM) experiments were performed at the PIRX and DEMETER end-stations in Polish synchrotron SOLARIS and at Nanospectroscopy beamline in Elettra (Italy). Magnetic properties of epitaxial CoO(111)/Fe(110) and NiO(111)/Fe(110) bilayers and nanostructures were followed. We find that in both studied cases ferromagnetic (FM) sublayer plays a dominant role and determines the magnetic state of the neighboring antiferromagnet (AFM), however completely different interaction mechanisms are involved. In CoO/Fe bilayers the AFM spins are totally frozen although their orientation is imprinted by magnetization of Fe layer when the system passes the Neel temperature of CoO. Once the Fe layer gratfs the particular magnetic anisotropy (MA) into the CoO overlayer, it later remains frozen and insensitive to external factors like external magnetic field or Fe magnetization direction. In contrast, for NiO/Fe bilayers we find that due to the weak intrinsic MA of NiO, the NiO spins are rotatable and always follow the reorientation of Fe magnetization that can be controlled by external magnetic field or via the temperature and thickness driven spin reorientation of Fe(110). In the case of the temperature induced spin reorientation transition in Fe(110), it allowed us to implement all-temperature, zero-field switching of AFM moments in NiO/Fe bilayers. Additionally we report on the in-plane magnetic anisotropy of antiferromagnetic NiO(111) films epitaxially grown on Cr(110) buffer layers on W(110) single crystal. Both structural and magnetic characterization of 40 Å thick NiO films was performed as a function of Cr layer thickness, starting from single pseudomorphic Cr monolayer (ML) up to 75 monolayers. Comparison of measured and calculated angular XMLD dependencies indicates that with increasing Cr thickness antiferromagnetic spins rotate from parallel to NiO[−211] towards NiO[01−1] direction within (111) sample plane. Analysis of LEED data reveals that such Cr thickness induced AFM SRT originates from evolution of epitaxial strain exerted on NiO layer by Cr buffer.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

EXPLORING EARTH'S EARLIEST ECOSYSTEMS WITH SYNCHROTRON-BASED TECHNIQUES: IMPLICATIONS FOR THE SEARCH FOR LIFE ON MARS

Keyron Hickman-Lewis,[1,*]
[1]*School of Natural Sciences, Birkbeck, University of London, United Kingdom*
**E-mail: k.hickman-lewis@bbk.ac.uk*

The fossil record of ancient life extends to approximately 3.5 billion years (Gyr) before the present; however, due to plate tectonics, weathering, diagenesis and metamorphism over long geological timescales, this record is sporadic and often poorly preserved. Traces of life in Earth's oldest rocks are often microscopic in scale and chemically subtle, their characterisation requiring high-resolution and high-sensitivity analytical approaches. Synchrotron-based analytical techniques are optimised for such studies. I will discuss how synchrotron-based techniques can advance beyond laboratory characterisation and shed new light on ancient fossils. I will specifically focus on our use of beamlines at SOLARIS (DEMETER STXM and POLYX μXRF and XAS) to evaluate the geochemical characteristics and potential metabolic networks preserved within fossilised microbial mats from throughout early Earth history, including Earth's earliest anoxygenic consortia from 3.4 Gyr-old marine environments, the unexpected preservation of biogeochemical complexity in 2.9 Gyr-old sandstones, and the organic and mineralogical characteristics of potential cyanobacterial communities from the dawn of oxygenic photosynthesis and atmospheric oxygenation approximately 2.5 Gyr ago. Combinations of multiple spatially resolved synchrotron techniques—including STXM characterisation of C and N bonding and μXRF mapping of trace metal concentrations within microbial fossils—have allowed both metabolic strategies and taphonomic (preservational) pathways to be interpreted in detail. When combined with traditional laboratory analyses (e.g. microscopy and spectroscopy), synchrotron-based approaches have significantly advanced our understanding of the nature of preservation of microbial fossils in deep time.

Advanced analytical techniques used for the evaluation of traces of ancient life on Earth are also anticipated to be essential for characterising potential traces of life in Martian rocks brought to Earth by Mars Sample Return. Following the discovery of a "potential biosignature" (a potential trace of life) by the NASA Mars 2020 *Perseverance* rover in 2024, it has become ever more pressing to develop applications of high-resolution approaches—including those at synchrotron facilities—in preparation for future analyses of such astrobiological materials, which may finally answer the question of whether Mars ever hosted life.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

TOWARDS UNDERSTANDING THE BENEFICIAL IMPACT OF SOFC ANODE CATALYTIC LAYERS THROUGH COMPLEMENTARY STUDIES AT SOLARIS AND ESRF

Beata Bochentyn[1,*], Agnieszka Witkowska[1], Agata Ducka[1], Kinga Kujawska[1], Jakub Zdankiewicz[1], Michał Dominów[1], Jakub Karczewski[1]

[1]*Faculty of Applied Physics and Mathematics, Gdansk University of Technology, 80-233 Gdańsk, ul. Narutowicza 11/12 Poland*

**E-mail: beata.bochentyn@pg.edu.pl*

The commercially used biogas-fed Solid Oxide Fuel Cells (SOFCs) with Ni-YSZ anode suffer from carbon deposition and sulfur poisoning during the internal reforming process of fuel. One of the possibilities to improve their stability is to use the additional catalytic layers of strontium titanate-based perovskites as well as ceria-based fluorites deposited on the anode side. Ceria shows high mobility of oxygen ions, high oxygen storage capacity (OSC), attractive redox catalytic properties and chemical compatibility with water and carbon dioxide at high temperatures. Moreover, the high oxygen mobility in ceria promotes the mechanism of carbon removal, which in turn should contribute to the stability of the catalysts in hydrocarbon conversion reactions. Another method is to exsolve metallic nanoparticles from the perovskite lattice of the anode catalytic layer. These nanoparticles can act as catalytic centers for the process of electrochemical oxidation of a fuel as well as for the internal reforming reactions. The exsolution process occurs under reducing conditions and offers an even distribution of particles as well as very well attachment to the host material. When bimetallic or even ternary alloys are formed, the properties of the materials can be even further improved.

The aim of the presentation is to discuss the correlation of doped strontium titanate and ceria superior catalytic activity in SOFC anode conditions vs. its structure and electrical properties. The near-edge (XANES) and extended (EXAFS) range spectra analysis allowed to reconstruct the local structure of elements both in the as-prepared and reduced ceramics, leading to a deeper understanding of the exsolution process in perovskite and fluorite structures depending on the external conditions, as well as a type of transition metal dopant. The structural properties will be complementarily presented with DIR-SOFC achievements and composition of outlet gasses from anode with additionally deposited catalytic layers. Both achievements and obstacles in understanding the anode activity will be discussed.

Acknowledgements

This work was supported by the National Science Center under grant No. 2021/42/E/ST5/00450. The access to ESRF was financed by the Polish Ministry of Science and Higher Education – decision no. 2021/WK/11 and under the CERIC-ERIC.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

HOW GE, MN AND TE CHANGED MY VIEW OF MAGNETISM

Juraj Krempaský
**E-mail:juraj.krempasky@psi.ch*

In this seminar, I will tell the story of a scientific journey through three elements—germanium, manganese and tellurium, and how progressively rearranging them changed my view of magnetism. The journey starts with experiments, we begin with GeTe, one of the simplest room-temperature ferroelectrics. Adding manganese might sound like a modest modification of the periodic table, but the magnetic consequences are anything but modest. In (Ge,Mn)Te, competing ferromagnetic, antiferromagnetic and antisymmetric Dzyaloshinskii–Moriya interactions coexist with ferroelectricity and strong spin–orbit coupling. The result is an intriguing correlated spin glass in which ferrimagnetic regions communicate collectively and can undergo magnetostochastic switching in response to well-defined external stimuli. In other words, disorder does not simply make the magnetism messy, it gives the system new ways to respond.

We then take the chemical experiment one step further: what happens if Ge is removed altogether and replaced by Mn? We arrive at MnTe, a near-room-temperature antiferromagnet that has recently become a canonical platform for altermagnetism. This emerging form of magnetism challenges the familiar division between ferromagnets and antiferromagnets: it combines zero net magnetization with a strongly spin-polarized electronic structure, bringing together properties previously thought difficult to reconcile within a single magnetic phase.

Is altermagnetism therefore earning its place as a third branch of the magnetic family tree? Our spin- and angle-resolved photoemission experiments provide direct insight into this question by revealing the characteristic lifting of spin degeneracy associated with the symmetry of the altermagnetic state.

The journey from GeTe, through (Ge,Mn)Te, to MnTe therefore takes us from ferroelectric Rashba physics, through a collectively responding multiferroic spin glass, to altermagnetism. Along the way, these three elements have provided a surprisingly rich playground for asking an apparently simple question: *how many different ways can a solid be magnetic?*

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

POLISH SYNCHROTRON RADIATION SOCIETY – SUPPORTING THE POLISH PHOTON-SCIENCE COMMUNITY

Agnieszka Witkowska[1,2,*]
[1]*Gdańsk University of Technology, 80-233 Gdańsk, Poland*
[2]*PTPS, ul. Radzikowskiego 152, 31-345 Kraków, Poland*
**E-mail: agnieszka.witkowska@pg.edu.pl*

The Polish Synchrotron Radiation Society (PSRS, https://synchrotron.org.pl) was established in 1991 during the 1st National Symposium of Synchrotron Radiation Users in Kraków. For more than three decades, the Society has supported the development and dissemination of research using synchrotron radiation (SR) and free-electron lasers (FELs), while contributing to the growth and integration of the Polish photon-science community. With around 170 members representing research institutions across Poland, PSRS brings together researchers working in physics, chemistry, materials science, biology, medicine and other fields in which advanced photon sources enable new scientific opportunities.

The Society organizes and co-organizes conferences, including the International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS), as well as schools, workshops and seminars on synchrotron and FEL science. PSRS also supports young researchers in participating in international scientific events and experiments, promotes access to synchrotron and FEL facilities through national and international initiatives (e.g. NEPHEWS project), and maintains close links with international user organizations (ESUO, IXAS, IUCr).

PSRS also actively promotes scientific and educational activities through publications, lectures and courses. These efforts include *the Bulletin of the Polish Synchrotron Radiation Society* regularly published since 2002, as well as the book *Synchrotron Radiation in Solid-State Physics and Chemistry: Selected Topics* prepared and published by the Society in 2024. Since 2018, the PSRS Awards have recognized outstanding research, doctoral theses, and scientific or outreach activities contributing to the development of synchrotron and FEL science.

A major milestone in the history of PSRS was the long-standing effort of its members to establish a synchrotron facility in Poland, which ultimately led to the construction of the SOLARIS synchrotron in Kraków. Today, close cooperation with the National Synchrotron Radiation Centre SOLARIS and support for the continued development of the Polish synchrotron user community remain important priorities of the Society. One example of this close collaboration is the Joint Meeting of the Polish Synchrotron Radiation Society Members and SOLARIS Centre Users, organized jointly by PSRS and the SOLARIS Centre since 2020.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

NEW GRANT FOR POLAND'S PARTICIPATION IN THE ESRF

Anna Wolska
Institute of Physics Polish Academy of Sciences, Al. Lotników 32/46 PL-02668 Warsaw, Poland
E-mail: Anna.Wolska@ifpan.edu.pl

Poland joined the ESRF in 2004 as an Associated Member, first with a contribution of 0.6 % and, since 2006, of 1% of the infrastructure budget. It opened the door to this very sophisticated infrastructure for Polish users. From the beginning Polish contribution to the ESRF is covered by the grants from the Ministry of Science and Higher Education. [1] The current grant will end on 31 December 2026.

The next grant, for years 2027-2031, is already under evaluation. Its main goal is to provide funds for the Polish contribution in order to continue Poland's access to the ESRF. However, other activities are also planned to support Polish users, among them one- and two-week scholarships, a possibility to train a new team member during beamtime at the ESRF, financing participation in conferences and the ESRF User Meetings. All the information will be available on the project website: https://esrf.ifpan.edu.pl/ together with the new acknowledgments formula. Till then, while presenting the results at conferences or publishing them in scientific journals, the users should use the present formula: *The access to the ESRF was financed by the Polish Ministry of Science and Higher Education, dec. no. 2021/WK/11*.

[1] A. Wolska**,** K. Lawniczak-Jablonska *"Polish contribution to the European Synchrotron Radiation Facility"* Bulletin of the Polish Synchrotron Radiation Society 23 (2023) 8.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

Ribosomes at work: Visualizing translational dynamics directly in cells via cryo-electron tomography

Magdalena Schacherl[1,2,*]

[1]*Institute of Medical Physics and Biophysics, Charité – Universitätsmedizin Berlin, Corporate member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany*
[2]*Małopolska Centre of Biotechnology (MCB), Jagiellonian University, Kraków, Poland*
**E-mail: magdalena.schacherl@charite.de*

Protein synthesis is a highly dynamic process that has traditionally been investigated using purified ribosomes and *in vitro* biochemical approaches [1-3]. While these methods have provided fundamental insights into the translation cycle, ribosome purification can alter the distribution of functional states, limiting our understanding of translation as it occurs within the native cellular environment. To fully capture translational dynamics, ribosomes must therefore be studied *in situ* [4].

In this talk, I will present how cryo-electron tomography (cryo-ET), combined with subtomogram averaging and advanced computational classification, enables direct visualization of translating ribosomes inside intact astrocytes at molecular resolution. By resolving distinct conformational and functional states, cryo-ET provides a snapshot of the cellular translation landscape, revealing the distribution of initiation, elongation, and higher-order ribosomal assemblies without the need for biochemical isolation.

Our analyses reveal an accumulation of ribosomes in decoding states within astrocytes, suggesting that codon–anticodon selection is a prominent kinetic step in the native cellular context. We also directly observe disomes and translation initiation complexes, providing evidence of active *in situ* translation. Finally, I will discuss how comparisons of ribosome state distributions between healthy and diseased cells reveal changes in translational dynamics, highlighting cryo-ET as a powerful approach to studying molecular processes in physiology and disease. I will conclude with an outlook on the planned implementation of an integrated cryo-correlative light and electron microscopy (cryo-CLEM) workflow at MCB/SOLARIS to enable targeted *in situ* structural studies linking cellular function and molecular architecture.

References: 1. Anger AM *et al. Nature* **497**, 80 (2013). 10.1038/nature12104; 2. Budkevich TV *et al. Cell* **158**, 121 (2014). 10.1016/j.cell.2014.04.044; 3. Behrmann E *et al. Cell* **161**, 845 (2015). 10.1016/j.cell.2015.03.052; 4. Xue L, Spahn CMT, Schacherl M and Mahamid J. *Nat Struct Mol Biol* **32**, 257 (2025). 10.1038/s41594-024-01441-0

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

BUILDING BEYOND THE ICOSAHEDRON: NOVEL VIRUS-LIKE PARTICLES AND THE STRUCTURAL BASIS OF THEIR ASSEMBLY

Joanna Śliwiak,[1]‡ Martyna Kordyś,[1]‡ Artur Biela, [2]‡ Miłosz Ruszkowski,[1] Agata Świątkowska,[1]and Anna Urbanowicz[1*]

[1] Protein Engineering and Biophysics Laboratory, Institute of Bioorganic Chemistry, Polish Academy of Sciences, Poznań, Poland

[2] SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Krakow, Poland

‡ The authors contributed equally

**E-mail: aniau@ibch.poznan.pl*

Virus-like particles (VLPs) are nanoscale protein assemblies with diverse applications in biotechnology and medicine, particularly as platforms for cargo encapsulation and targeted delivery. In this study, VLPs derived from Red Clover Necrotic Mosaic Virus (RCNMV) were used as a model to investigate the mechanisms of capsid self-assembly and cargo encapsidation. Cryo-electron microscopy (cryo-EM) analysis of VLPs assembled in the presence of different cargo molecules revealed the formation of previously unreported non-icosahedral architectures exhibiting remarkable structural diversity, including multiporous morphologies. Notably, the observed particle geometries appeared to depend on the nature of the encapsulated cargo. Density maps obtained for several of these assemblies provided evidence of cargo encapsidation within the particles. Furthermore, cryo-EM micrographs captured putative assembly intermediates as structural building blocks of these VLPs, offering unique insights into the early stages of the in vitro self-assembly process. These observations shed light on the molecular mechanisms governing capsid formation and provide a structural basis for the pronounced plasticity of RCNMV capsid protein in vitro self-assembly.

The research was supported by the Medical Research Agency grant no. ABM/2021/5/00004-00 and computational grants no. PLG/2024/017833 and PLG/2025/018682 at ACK Cyfronet AGH facilities. Research at the National Synchrotron Radiation Centre SOLARIS is supported by the Ministry of Science and Higher Education, Poland, under contract no. contract no. 1/SOL/2021/2.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

THE ENIGMA OF NIF3. STRUCTURE WITHOUT THE FUNCTION.

Elżbieta Wątor-Wilk[1,*] Krzysztof Żak[2], Piotr Wilk[2], Marcin Jaciuk[3] and Przemysław Grudnik[2]

[1]Jerzy Haber Institute of Catalysis and Surface Chemistry Polish Academy of Sciences, Krakow, Poland.

[2]Małopolska Centre of Biotechnology, Jagiellonian University, Kraków, Poland

[3]National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Kraków, Poland

**E-mail: elzbieta.wator-wilk@ikifp.edu.pl*

The NIF3 protein remains one of the most enduring enigmas awaiting characterization. Highly conserved across eukaryotes, its biological function is still unknown. Although only limited functional insights exist, NIF3 has been linked to a variety of cellular processes, including DNA repair, DNA methylation, iron homeostasis, cellular stress, and virulence. In humans, altered NIF3 expression has been associated with diseases such as cancer, osteoporosis, and neurodegenerative disorders, although these links appear highly pleiotropic. While prokaryotic NIF3 homologs have been structurally characterized, no structural information has been available for eukaryotic homologs, including the human protein. To address this gap, we set out to provide the first detailed structural characterization of NIF3 from higher eukaryotes (human and mouse), alongside the yeast homolog, revealing features that may inform its function and evolutionary divergence.

We determined X-ray crystal and cryoEM structures of these eukaryotic NIF3 proteins. A key discovery is that NIF3 in higher eukaryotes contains a unique insertion, the “cap” domain, which is absent in yeast but present in some bacterial homologs, such as *Staphylococcus aureus*. Crucially, we observed that the presence of this cap domain drives dynamic changes in the protein's oligomerization state. Furthermore, mutation of a conserved histidine converts the metal-binding site from a di-ion to a single-ion configuration, suggesting functional plasticity.

These structures offer the first molecular view of NIF3 in higher eukaryotes and yeast, highlighting species-specific adaptations and structural features that may regulate activity. While the protein’s exact function remains elusive, this work establishes a foundation for future mechanistic studies.

The study is funded by National Science Centre SONATINA grant 2024/52/C/NZ1/00271 (to E.W.W).

CryoEM-Guided Engineering of Extracellular Vesicles for Regenerative Medicine and Precision Genome Editing

Sylwia Bobis-Wozowicz[1]*, Julia Piekarska-Wylęgała[1], Kinga Fic[1], Görkem Efendioğlu[1], Krzysztof Kuśka[1], Paulina Indyka[2], Michał Rawski[2]

[1]Department of Cell Biology, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, Kraków, Poland
[2]SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Krakow, Poland.
*Corresponding author: sylwia.bobis@uj.edu.pl

Extracellular vesicles (EVs) are emerging as promising biological nanotherapeutics for regenerative medicine and targeted drug delivery. Cryogenic electron microscopy (CryoEM) enables visualization of EVs in their native state and has become a key tool for structural characterization and quality assessment of EV-based therapeutics.

We characterized EVs derived from human induced pluripotent stem cells (hiPSCs), umbilical cord-derived mesenchymal stromal cells (UC-MSCs) and human bronchial epithelial cells (BEAS) using CryoEM. High-resolution imaging revealed intact lipid bilayers, nanoscale morphology and structural heterogeneity, establishing morphological fingerprints of EV populations from different cellular sources.

Functional studies demonstrated that hiPSC-derived EVs exert potent anti-fibrotic effects *in vitro* and *in vivo* by reducing myofibroblast activation and extracellular matrix deposition while promoting tissue regeneration. In parallel, EVs are being developed as natural nanocarriers for bioactive molecules, including the CRISPR/Cas system for precise genome editing. This allows using EVs as multifunctional platforms for the treatment of human diseases, including a genetic disease - cystic fibrosis.

Together, CryoEM-guided structural characterization and functional studies provide a framework for the rational engineering and quality assessment of next-generation extracellular vesicle-based Advanced Therapy Medicinal Products (ATMPs).

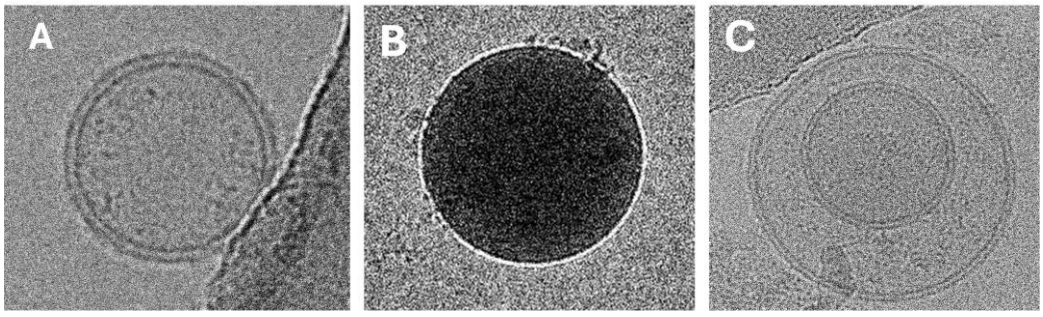


Figure 1. Representative CryoEM images showing native membrane architecture and structural heterogeneity of extracellular vesicles.

This study was supported by the Foundation for Polish Science (FIRST TEAM, project FENG.02.02-IP.05-0064/23, Innovative Treatment Strategy for Cystic Fibrosis), co-financed by the European Union under the European Funds for Smart Economy (FENG) 2021–2027.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

CAPTURING "PROTEIN SPAGHETTI": BIOSAXS AND FRAP ANALYSIS OF PHASE-SEPARATED PLANT CWC22

Marta Gapińska[1,*] Olaf Geyderowicz,[1] Mark Tully,[2] Marta Koblowska[1]
[1] *Faculty of Biology, University of Warsaw, Warsaw, Poland*
[2] *European Synchrotron Radiation Facility, Grenoble, France*
*E-mail: ma.gapinska@uw.edu.pl corresponding/presenting author

CWC22 is an evolutionarily conserved splicing factor present in nearly all spliceosomes studied to date [1]. In *A. thaliana*, our results indicate that CWC22 is essential for embryonic development, while previous work in our group links it to plant stress response. In this work, we focus on CWC22 as a stress-related, phase-separating plant protein whose conserved splicing role provides the biological context, but not the main structural question.

Plant CWC22 contains two structured domains connected by a flexible linker and flanked by intrinsically disordered regions. Such regions are difficult to describe by classical structural biology, yet they often mediate liquid–liquid phase separation (LLPS), a process increasingly recognized as important in plant stress responses [2]. We therefore combined synchrotron BioSAXS, mass photometry and fluorescence recovery after photobleaching (FRAP) to characterize both the structural organization and dynamics of CWC22 assemblies.

Using BM29 BioSAXS beamline at the ESRF, Grenoble, we monitored purified CWC22 in the dilute phase and under phase-separating conditions. In the dilute phase, SAXS revealed an oligomeric equilibrium and enabled modelling of tetrameric and octameric assemblies. Under LLPS-promoting conditions, SAXS captured ordered intermolecular correlations within CWC22 condensates. In parallel, FRAP experiments in plant cells showed that CWC22 condensates remain dynamic *in vivo*, consistent with liquid-like molecular exchange.

Together, these results show that plant CWC22 is not merely a conserved spliceosomal factor, but a multivalent, structurally flexible protein capable of forming dynamic condensates. By linking synchrotron BioSAXS with orthogonal biophysical and live-cell approaches, we provide a framework for understanding how structured oligomerization and intrinsic disorder cooperate in organizing stress-related plant protein assemblies.

[1] Black et al., RNA 2023, doi: 10.1261/rna.079273.122.
[2] Liu et al., Plant Commun. 2024, doi: 10.1016/j.xplc.2023.100663.
The work presented in this paper benefits from the support received from the Polish Ministry of Science and Higher Education, dec. no. 2021/WK/11.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

SCIENTIFIC CAPABILITIES OF THE S-SNOM/AFM-IR ENDSTATION

Maciej Roman,[1,*] Julia Chudzik,[1] Kaja Piana,[1] and Tomasz P. Wróbel[1]

[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*

**E-mail: maciej.roman@uj.edu.pl*

The Chemical Infrared Imaging (CIRI) beamline is focused on infrared imaging and spectroscopy at the micro- and nano-scale. The beamline consists of three endstations, i.e. an FT-IR microscope, an O-PTIR microscope, and an s-SNOM/AFM-IR system. The s-SNOM/AFM-IR system (attocube systems GmbH, Germany) is equipped with nanoimaging and nanospectroscopy modules for IR s-SNOM and AFM-IR measurements. Furthermore, the system uses a Quantum Cascade Laser (QCL) as an IR light source, and since December 2024, it has been coupled with a synchrotron beam.

The s-SNOM/AFM-IR system can be applied in many fields of molecular science and quantum matter studies, including the determination of protein structure, identification of functional groups, and studies on phonons, polaritons, conductivity, and so on. Its wide scientific capabilities have been confirmed in many studies performed at the CIRI beamline so far. For instance, s-SNOM imaging was used to confirm the presence of carbon dots and to assess their distribution and aggregation in the combined system with L- and D-cysteine [1]. Such a system is chiral and shows a much stronger VCD signal than the signal obtained for pure amino acids. This technique was also applied for tracking the absorption kinetics of extracellular DNA on ferrihydrite nanoparticles in the absence and presence of bacterial biomass [2]. DNA adsorption is minor in the absence of biomass. On the other hand, the adsorption of DNA and other biomolecules increases significantly as biomass concentration increases. Finally, s-SNOM imaging and nano-FTIR spectroscopy were successfully used to detect three micron PMMA spheres immersed in water under the SiN membrane.

Acknowledgements

This project is executed under the provision of the Polish Ministry of Science and Higher Education project „Support for research and development with the use of research infrastructure of the National Synchrotron Radiation Centre SOLARIS” under contract no. 1/SOL/2021/2.

References

[1] M. Pawlak, et al., ACS Nano 20 (2026) 11219–11229

[2] M. Skalny, et al., Langmuir 42 (2026) 16131–16144

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

STRUCTURAL DIVERGENCE IN FERRITE-SILICA NANOCOMPOSITES

Adam Czempik,[1,*] Barbara Liszka,[1] Fabien Grasset,[2,3] Krystian Prusik,[1] Joanna Klimontko,[1] Mateusz Dulski,[1] Marcin Fijałkowski,[1] Jerzy Kubacki,[1] Ewa Partyka-Jankowska,[4] Tomasz Sobol,[4] Marcin Zając,[4] Edyta Beyer,[4] Barbara Wolanin,[4] Sabina Lewińska,[5] Sandy Auguste,[6] Anthony Rousseau,[6] Nirina Randrianantoandro,[6] and Anna Bajorek[1]

[1]*University of Silesia in Katowice, 40-007 Katowice, Poland*

[2]*Université de Rennes, F-35000 Rennes, France*

[3]*National Institute for Materials Science, 305-0044 Tsukuba, Japan*

[4]*SOLARIS National Synchrotron Radiation Centre, 30-392 Kraków, Poland*

[5]*The Institute of Physics of the Polish Academy of Sciences, 02-668 Warszawa, Poland*

[6]*Le Mans Université, 72085 Le Mans, France*

**E-mail: adam.czempik@us.edu.pl*

Ferrite-silica nanocomposites (MFe_2O_4@SiO_2, where M = Ni, Co, Zn, or their mixtures) configured in core-shell [1] or matrix-embedded [2] architectures are promising candidates for magnetic hyperthermia (MH) in cancer treatment. The annealing process, used for tuning the properties of the nanocomposites, strongly depends on their architecture. This work presents a comprehensive structural and magnetic analysis, highlighting X-ray absorption near-edge structure (XANES) spectroscopy conducted at SOLARIS. The results provide a deeper understanding of the nanostructure modification, offering insights into the design of MH agents.

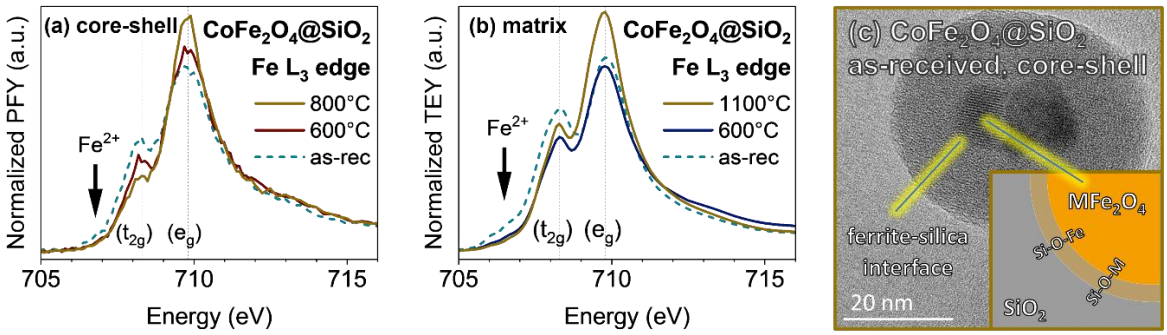


Figure 1 – XANES spectra of $CoFe_2O_4$@SiO_2 nanocomposites of a (a) core-shell or (b) matrix embedded architectures, in their as-received (as-rec) and annealed forms. Upon annealing, the occupancy of the ferrite crystal lattice changes, and the disordered ferrite-silica interface (c) is reduced, as evidenced in (a, b) in the region corresponding to Fe^{2+}. The data were collected at the PIRX beamline (proposals 249037 and 242025).

[1] A. Bajorek, A. Czempik et al., J. Magn. Magn. Mater. 636 (2025) 173670

[2] A. Czempik et al., IEEE Transactions on Magnetics (2026 – Early Access)

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

X-RAY ABSORPTION SPECTROSCOPY INVESTIGATION OF PRESSURE-DRIVEN SPIN CROSSOVER IN A TWO-DIMENSIONAL HOFMANN CLATHRATE

Wojciech Sas,[1,*] Piotr Konieczny,[1] Aleksandra Pacanowska,[1] Andrei Rogalev,[2] Fabrice Wilhelm,[2] Alexey Maximenko,[3] Grzegorz Gazdowicz,[3] and Magdalena Fitta[1]

[1]*Institute of Nuclear Physics Polish Academy of Sciences, Radzikowskiego 152, 31-342 Kraków, Poland*

[2]*ESRF – The European Synchrotron Radiation Facility, CS 40220, 38043 Grenoble, Cedex 9, France*

[3]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, ul. Czerwone Maki 98, 30-392 Kraków, Poland*

**E-mail: wojciech.sas@ifj.edu.pl*

Spin-crossover (SCO) compounds are prominent candidates in multifunctional materials because of their bistable nature and porous structures. Within this class, Hofmann clathrates – coordination polymers built from 2D $[M^{II}(CN)_4]^{2-}$ layers linked by organic ligands – stand out for their robustness. In contrast to many molecular systems, they typically exhibit isostructural transitions, where the framework remains preserved while bond lengths vary, enabling excellent cycling stability. In this work, we investigate the pressure-induced SCO behavior in a 2D iron-nickel Hofmann clathrate: {[Fe(pyridazine)$_2$Ni(CN)$_4$]}, Fe(pdz)Ni, by X-ray absorption spectroscopy (XAS) using a diamond anvil cell (DAC). In particular, we study the evolution of the spin-state during the application of pressure within the range 0-1.04 GPa, and compare it to the temperature-driven spin transition at ambient pressure. The results show that Hofmann clathrates are promising candidates for sensitive pressure-temperature sensors.

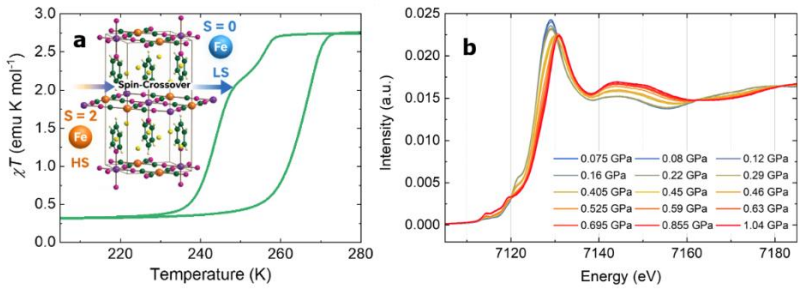


Figure 1. Magnetic susceptibility vs. temperature and crystal structure of Fe(pdz)Ni (a). Pressure-induced Fe K-edge XAS spectra of Fe(pdz)Ni (b).

Acknowledgements: The access to ESRF was financed by the Polish Ministry of Education and Science – decision number: 2021/WK/11.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND
SOLARIS CENTRE USERS

Enhancing the power density of a multinuclear Cobalt (II) cluster by the addition of a redox active electrolyte

Javed Hussain Shah[1], Shahzad Sharif[1], Muhammad Shahbaz[1], Ali Hamza[1], Onur Sahin[2]

[1]Materials Chemistry Laboratory, Department of Chemistry, Government College University Lahore, 54000 Pakistan

[2]Department of Occupational Health & Safety, Faculty of Health Sciences, Sinop University, TR-57000, Sinop, Turkey

javedchemist@gmail.com

To meet the ever-increasing demand of energy, hybrids of supercapacitor and batteries have grabbed broad attention of the researchers. Various classes of compounds have been explored as a promising candidate for hybrid materials; however, emerging class of MOFs have distinctive properties due to which they have been integrated in energy storage devices to amalgamate energy density and power density in a single unit. Herein, a novel cobalt(II) cocrystal consisting of mononuclear, dinuclear and trinuclear complexes, with the overall composition, $[Co_{13}(Pydc)_{10}(PydcH)_6(H_2O)_{24}].14H_2O$ (**1**) ($Pydc^{2-}$ = Pyridine-2,6-dicarboxylate) has been synthesized and its structure been established by single-crystal X-ray diffraction. The crystal structure of the compound shows that it is an aggregate of seven complexes, including: two mononuclear $\{[Co(Pydc)(Pydc\text{-}H)]^-\}$ complexes, four dinuclear species {two of each type, $[Co_2(Pydc)_2(H_2O)_5]$ and $[Co_2(Pydc\text{-}H)_2(H_2O)_5]^{2+}$} and a trinuclear $\{[Co_3(Pydc)_4(H_2O)_4]^{2-}\}$ complex. The electrochemical properties of the synthesized cobalt compound (**1**) were investigated in order to demonstrate its potential for the practical applications. Three- and two-electrode assemblies were utilized for the construction of a battery device. Fabrication of a battery comprising the compound **1** and activated carbon (AC) possesses a specific capacity of 99.3 Cg^{-1}, energy density of 20.4 $Whkg^{-1}$ and power density of 825 Wkg^{-1}. Dunn's method was employed to distinguish between capacitive and diffusive controlled electrochemical reaction mechanisms in the fabricated battery. The capacitive behaviour of the asymmetric Co//AC cell was enhanced by addition of $K_4[Fe(CN)_6]$ as a redox active species. The battery fabricated by respective method exhibited a specific capacity of 99.3 Cg^{-1}, energy density of 35.3 $Whkg^{-1}$ and power density of 1280 Wkg^{-1}. The cyclic stability of 97% was achieved even after 5000 GCD cycles. Depending on the good initial findings of the electrochemical analysis, the electrode qualifies as a promising candidate for an efficient electrode material for ultra-modern reserves of energy application.

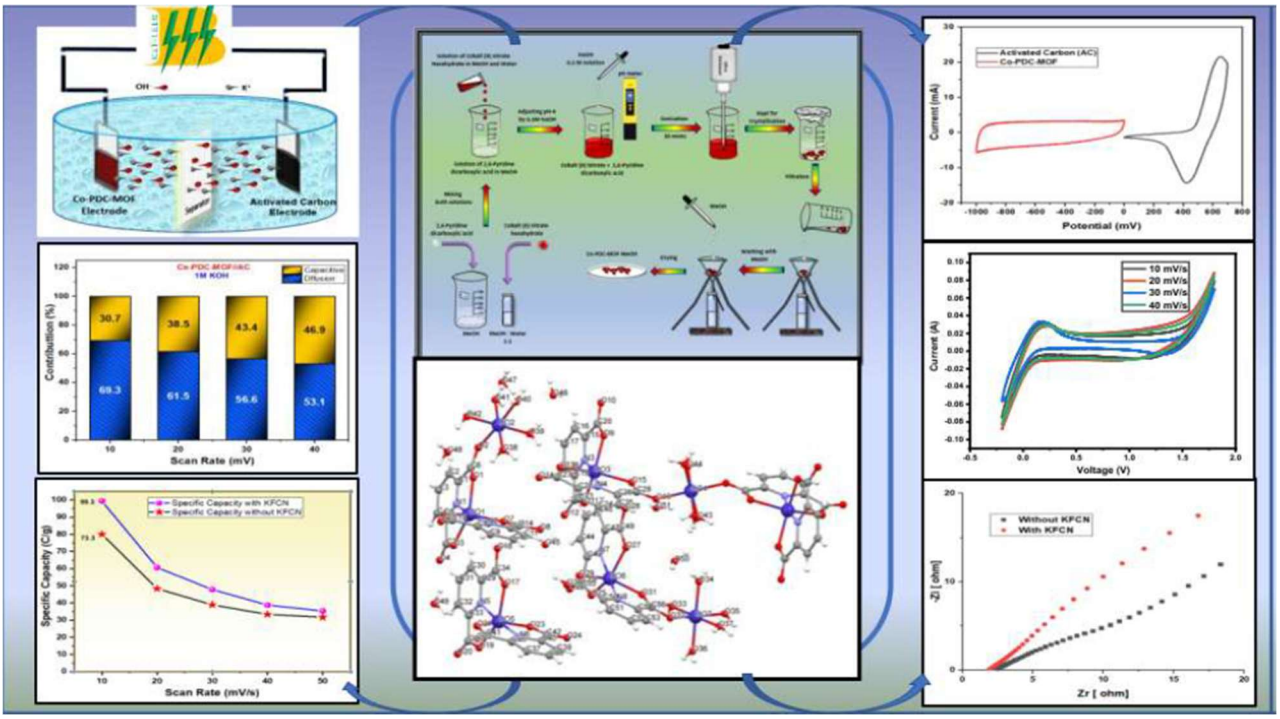


Figure. Graphical Abstract

Acknowledgement:

We greatly acknowledge the assistance and support of Department of Chemistry, Government College University Lahore Pakistan.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

Mapping magneto-chemical heterogeneity in laser-synthesized bimodal colloids via synchrotron XAS and STXM

Mohammad Sadegh Shakeri, Arkadiusz Zarzycki, Zaneta Swiatkowska-Warkocka
Institute of Nuclear Physics Polish Academy of Sciences, Krakow, PL-31342 Poland
* ms.shakeri@ifj.edu.pl

Abstract
The engineering of magnetic nanomaterials with tailored stoichiometry and bimodal size distributions is critical for applications ranging from targeted drug delivery to high-contrast MRI. This study investigates a novel sub-ablation dual-synthesis regime during the laser processing of magnetite colloids. We hypothesize that a hot-skin effect triggers simultaneous surface atom shedding and confined volume fusion, resulting in a bifurcated population of ultrafine nanoclusters and submicron spheres [1]. To resolve the complex magneto-chemical gradients inherent in this non-equilibrium process, we employed a multi-modal synchrotron-based approach. Hard X-ray absorption spectroscopy (XAS) at the Fe K- edge was utilized to quantify the phase transformation between thestarting magnetite and the resulting fragmented cloud [2]. Through linear combination fitting of the XAS data, we identified a significant drop in Fe^{2+} content (from 31% to <8%) in the fragmented population, signaling a rapid, solvent-mediated oxidation into maghemite. This allowed us to correlate the laser-induced thermal gradients with the resulting cationic vacancy density. To visualize these transitions at the single-particle level, scanning transmission X-ray microscopy (STXM) was performed. STXM mapping at the Fe L2,3-edges provided spatially resolved chemical fingerprints of the bimodal distribution. By extracting local absorption spectra from the submicron fused cores and the surrounding fragmented clusters, we directly mapped the magneto-chemical heterogeneity of the colloid. STXM results confirmed that while the fused spheres maintain a magnetite-rich core, the ejected fragments undergo a complete phase shift. This synergy of XAS and STXM provides an unprecedented view of the structural and electronic evolution in laser-driven colloids, validating our predictive multiscale models and offering a blueprint for the deterministic synthesis of graded magnetic nanomaterials.

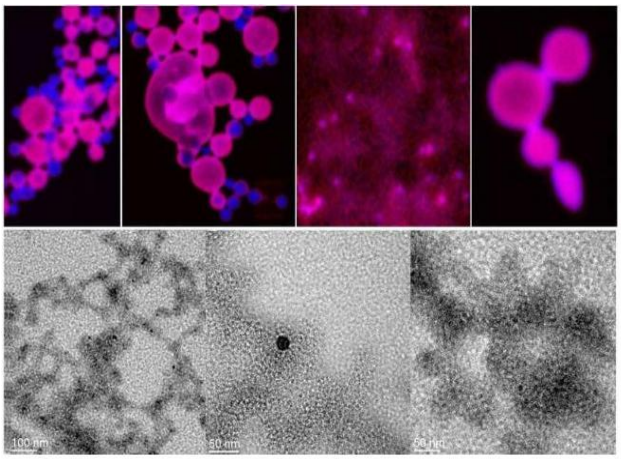


Fig. 1. STXM and HRTEM of biomodal synthesis

[1] Mohammad Sadegh Shakeri, et al. Advanced Functional Materials, 2023, 2304359.
[2] Mohammad Sadegh Shakeri, et al. Composites Part B: Engineering, 2025, 112457.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ANALYSIS OF Ti AND TiO_2 NANOLAYERS IRRADIATED WITH HCI Xe^{Q+} USING SR-GIXRF AND SR-XRR METHODS

R. Stachura[1,2], A. Kubala-Kukuś[1,3], P. Jagodziński[1,2], D. Banaś[1,3], I. Stabrawa[1,3], K. Szary[1,3], G. Wesołowski[1], G. Aquilanti[4], I. Božičević Mihalić[5], I. Carlomagno[6], J. R. Herrera[6], Md A. Alam[7], M. K. Tiwari[8]

[1]*Institute of Physics, Jan Kochanowski University, Kielce, Poland*

[2]*Central Office of Measures, Warszawa, Poland*

[3]*Holycross Cancer Center, Kielce, Poland*

[4]*The International Atomic Energy Agency, Vienna, Austria*

[5]*Rudjer Boskovic Institute, Zagreb, Croatia*

[6]*Elettra - Sincrotrone Trieste, Basovizza, Trieste, Italy*

[7]*Forschungszentrum Jülich GmbH, Jülich, Germany*

[8]*Raja Ramanna Centre for Advanced Technology, Indore, India*

**E-mail: regina.stachura@ujk.edu.pl*

Highly charged ions (HCIs) are used for controlled modification of nanomaterials. During ion-surface interactions, both potential and kinetic energy are deposited on the near-surface region, inducing structural and compositional alterations. However, the mechanisms responsible for these modifications are still under investigation [1, 2]. Low-angle X-ray methods offer a powerful and non-destructive analysis of such effects. X-ray reflectometry (XRR) provides information on layer thickness, density, and interface roughness. Grazing incidence X-ray fluorescence (GIXRF) enables depth-sensitive elemental analysis. In this study, nanolayers were irradiated with HCIs at the Kielce EBIS facility at Jan Kochanowski University in Kielce, and investigated using SR-XRR and SR-GIXRF methods at the XRF beamline of the Elettra Synchrotron in Trieste (Italy), with an energy of 6.0 keV [3, 4]. The experimental results will be presented and discussed. In addition, the XRR data were analysed using XRRModeler, a software tool developed for the simulation and fitting of XRR curves from multilayer structures. The combination of experimental measurements and computational modelling allowed a detailed characterization of irradiation-induced changes and demonstrated the potential of low-angle X-ray techniques for investigating ion-modified nanomaterials.

Acknowledgements: This work was co-financed by the Minister of Science under the "Regional Excellence Initiative" program (project no.: RID/SP/ 0015/2024/01).

[1] I. S. Elkamash, W. M. Moslem et al., Phys. Rev. E, 113 (2026), 035502.

[2] M. D. Majkić, N. N. Nedeljković et al., Phys. Status Solidi RRL, 20 (2026), e202500028.

[3] R. Stachura, D. Banaś et al., X-Ray Spectrom., 54 (2025), 70029.

[4] R. Stachura, D. Banaś et al., Nucl. Instrum. Meth. Phys. Res. B, 540 (2023), 64–71.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

FIRST DEMONSTRATION OF X-RAY PTYCHOGRAPHY AT THE SOLARIS STXM

K. Matlak,[1,*] T. Strączek,[1] W. Tomczyk,[2] P. Nita,[3] T. Tyliszczak,[1] and A. Mandziak[1]
[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Kraków, PL*
[2]*Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, PL*
[3]*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, PL*
**E-mail: krzysztof.matlak@uj.edu.pl*

The Scanning Transmission X-ray Microscope (STXM) installed at the DEMETER beamline of the SOLARIS National Synchrotron Radiation Centre has been continuously developed to provide advanced imaging capabilities for the user community. The beamline is based on a Plane Grating Monochromator (PGM) equipped with an Elliptically Polarizing Undulator (EPU), providing linear horizontal, linear vertical, and circular polarization modes for advanced spectromicroscopy studies, including magnetic materials investigations.

A major recent development of the SOLARIS STXM is the implementation of X-ray ptychography. After initial commissioning attempts, a successful experiment demonstrated improved spatial resolution compared with conventional STXM imaging. Using a 50 nm Fresnel zone plate (FZP) with a nominal spatial resolution of 61 nm, ptychographic reconstruction achieved 22 nm resolution. The measurement was performed using a defocused beam with a diameter of approximately 1.1 μm, reducing the photon density on the sample by more than two orders of magnitude compared with focused-beam operation. This approach may provide an important advantage for imaging radiation-sensitive materials while maintaining high-resolution information.

Dedicated software tools developed in collaboration with the Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN) support ptychographic data acquisition and processing workflows. The poster will present the first successful ptychographic results obtained at the SOLARIS STXM microscope and the developments enabling future applications of this technique for advanced materials studies.

Acknowledgements:
This project was partially developed under the provision of the Polish Ministry and Higher Education project "Support for research and development with the use of research infrastructure of the National Synchrotron Radiation Centre SOLARIS" under contract no. 1/SOL/2021/2.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

EXPERIMENTAL VALIDATION OF A CMOS-BASED BRAGG CRYSTAL SPECTROMETER AT THE SOLARIS SYNCHROTRON

Żaneta Szaforz,[1,*] Mirosław Kowaliński,[1] Jarosław Bąkała,[1] Marek Stęślicki,[1] Daniel Ścisłowski,[1] Janusz Sylwester,[1] Piotr Podgórski,[1] Grzegorz Gazdowicz,[2] Marcin Brzyski[2] and Marcel Piszak[2]

[1]*Centrum Badań Kosmicznych Polskiej Akademii Nauk, 00-716 Warszawa, Poland*

[2]*Narodowe Centrum Promieniowania Synchrotronowego SOLARIS, 30-392 Kraków, Poland*

**E-mail: zs@cbk.pan.wroc.pl*

High-resolution X-ray spectroscopy remains one of the most powerful diagnostic methods for investigating high-temperature plasmas in both astrophysical and laboratory environments. As part of the development of the BEES (Bragg Experiment for Exploration of the Sun) instrument concept, previously referred to as BRAXIS, an experimental campaign was conducted at the ASTRA beamline of the SOLARIS synchrotron to evaluate the performance of a modern Bragg crystal spectrometer employing a backside-illuminated CMOS detector.

The tested prototype consisted of a cylindrically bent Si(111) crystal coupled to a GSENSE400BSI detector operating in single-photon counting mode. Synchrotron radiation provided a stable and well-characterized X-ray source for assessing key instrument parameters, including spectral response, detector performance, crystal alignment sensitivity, and calibration procedures. The measurements also enabled verification of data processing methods and identification of instrumental effects relevant for future observations.

The experiment demonstrated the feasibility of combining contemporary CMOS detector technology with classical Bragg spectroscopy. High quantum efficiency, low readout noise, and rapid image acquisition were achieved, while the collected data provided valuable insight into the practical challenges associated with detector artifacts, mechanical alignment, and spectral calibration. The results constitute an important step toward the optimization of the BEES instrument and illustrate the role of synchrotron facilities in the development and validation of next-generation space instrumentation for solar X-ray observations.

Acknowledgements: This research was funded by the National Science Centre, Poland, grant No. 2025/57/B/ST9/01445. The synchrotron measurements were carried out at the SOLARIS National Synchrotron Radiation Centre under Project ID: 233037.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

Autonomous Sampling α-Fe_2O_3 Hollow Microspheres with Carbon-Stabilized Defects: Calcination-Tuned Humidity Sensor Performance

Islam Gomaa [a*], Mohamed Morsy [a,b], Raiedhah A. Alsaiari [c], Moustafa A. Rizk [c]

[a] Nanotechnology Research Centre (NTRC), The British University in Egypt (BUE), Suez Desert Road, El-Sherouk City, Cairo 11837, Egypt.

[b] Building Physics and Environment Institute, Housing & Building National Research Center (HBRC), Dokki, Giza 12311, Egypt

[c]Department of Chemistry, College of Science and Art in Sharurah, Najran University, Najran P.O. Box 1988, Saudi Arabia

**E-mail*: islam.gomaa@bue.edu.eg. */presenting author*

Control of defects and surface chemistry in metal-oxide sensors remains a significant challenge for achieving ultrahigh sensitivity and rapid response in humidity monitoring. Herein, we present a scalable mechano-thermal route to synthesize carbon-doped α-Fe_2O_3 hollow microspheres with built-in voids acting as autonomous sampling chambers. By systematically varying calcination temperature (500–900 °C), we tune crystallite size (38.2–87.6 nm), lattice strain (0.10–0.77%), dislocation density (1.4×10^{-4}–3.07×10^{-3} nm^{-2}), and C content (21→14 wt.%), thereby carbon-oxygen moiety that govern water adsorption and proton-hopping conduction. XPS/XAS confirm unusual stable Fe^{2+}/Fe^{3+} surface ratio and C–Fe–O interactions and hydrophilic sites, facilitating a dual-regime sensing mechanism transitioning from ionic conduction (11–75%RH) to Grotthuss-mediated proton transport (>75%RH), with unpredicted non-monotonic structural rearrangements at 800 °C underscore the critical role of transient Fe_3O_4 nucleation in defect activation. The Fe-500 sensor exhibits exceptional performance of 0.75 kΩ/%RH, response time of 40 s, and recovery time of 85 s, outperforming benchmark hematite-based devices..

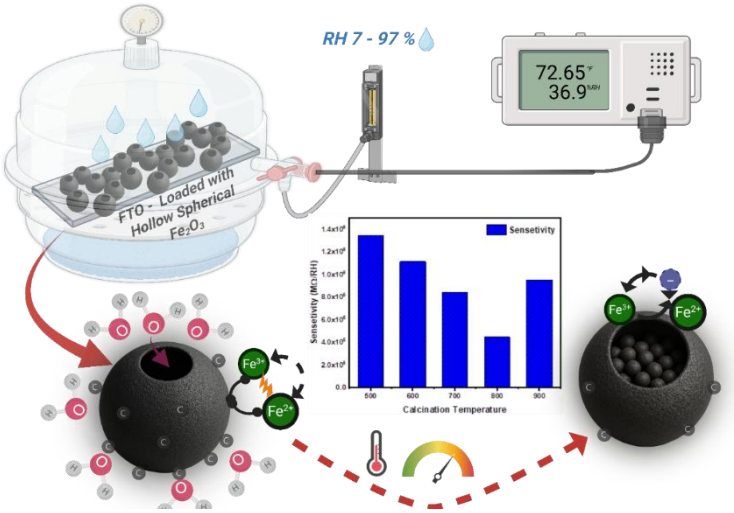
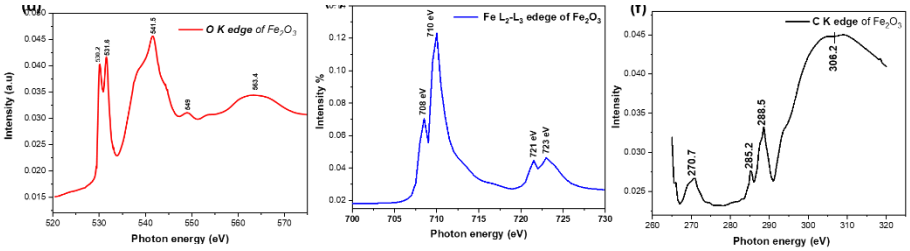


Figure 2: X-ray absorption spectra at the O K-edge (c), Fe $L_{2,3}$-edge (d), and C K-edge (e) for Sphere.



JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

IMPACT OF THE DISORDER ON THE XAS AND XPS SPECTRUM OF Ti_2MnAl HEUSLER COMPOUND AND THE LIMITATIONS OF THE NON-SYNCHROTRON LIGHT SOURCES FOR STUDYING THIS PROBLEM

JERZY GORAUS[1], *JERZY KUBACKI*[1], *WOJCIECH GUMULAK*[1], *ADRIAN BARYLSKI*[2], MARCIN ZAJĄC[3]

1. Chełkowski Institute of Physics, University of Silesia, 75 Pułku Piechoty 1a, 41-500 Chorzów, Poland

2.Institute of Materials Engineering, University of Silesia, 75 Pułku Piechoty 1a, 41-500 Chorzów, Poland

3. National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Czerwone Maki 98, 30-392 Kraków, Poland

**E-mail: wojciech.gumulak@us.edu.pl /presenting author*

Ti_2MnAl was claimed to have Spin Gapless Semiconducting (SGS) properties, however, this can only be realized in one of the variants of crystal structure. In this work, we show our results obtained from X-ray Photoemission Spectroscopy (XPS) and X-ray Absorption Spectroscopy (XAS) and we compare them with simulations for eight structural models obtained from ab-initio calculations. These spectroscopic measurements are sensitive mostly to the sample surface, therefore, we used them to probe whether the surface exhibits the same structure as the sample bulk, which was studied in earlier papers. Careful analysis of these results suggests that the Ti_2MnAl crystal structure observed on the surface is the same as the bulk crystal structure. It is of regular, Cu_2MnAl type, which excludes the possibility of the existence for SGS state on the surface. We also discuss the limitations of the XPS technique using a standard Al anode X-ray source to resolve the correct structure of that material. During our experiments, we found that the material was quite hard. We studied the surface of the sample with an indentation probe and found that it has a hardness comparable to hardened steel.

Keywords: intermetallics, density functional theory, surface properties, elastic properties, ab_initio calculations, nanoindentation

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

NEUTRON ACTIVATION ANALYSIS LABORATORY AT NCPS SOLARIS

Michał Silarski,[1,*] and Katarzyna Dziedzic-Kocurek,[1]

[1] *Jagiellonian University, Faculty of Physics, Astronomy, and Applied Computer Science, Institute of Physics*

**E-mail: michal.silarski@uj.edu.pl*

The Neutron Activation Analysis Laboratory (NAAL), established at the National Synchrotron Radiation Centre SOLARIS, provides access to fast neutrons with energies of up to 14 MeV, as well as thermal and epithermal neutron fluxes generated by a compact DT neutron generator. The facility supports fundamental and applied research in materials science, medical physics, biophysics, and the non-invasive detection of hazardous materials.

NAAL is designed to advance research in the development and characterization of materials for radiation detectors and shielding systems, the development of boron neutron capture therapy (BNCT), and neutron-based techniques for hazardous material detection. In particular, it enables comprehensive characterization of radiation detectors and dosimetric systems under gamma and neutron irradiation over an energy range that cannot be achieved using conventional isotopic sources. The laboratory also provides a unique environment for investigating the radiation shielding performance of novel materials, including biomaterials, as well as their radiation-induced aging and degradation.

In the fields of medical physics and biophysics, NAAL offers new opportunities for research on BNCT and, more broadly, neutron capture therapies. Planned studies include preliminary in vitro experiments on cell lines using novel boron- and gadolinium-based carriers to support the development and optimization of these therapeutic approaches. Another important research direction is public safety, with a focus on the non-invasive detection of hazardous materials using neutron activation techniques. The development of such methods has become increasingly important in light of the current geopolitical landscape.

This presentation will provide an overview of the current research activities of our group in these areas, the present status of the NAAL facility, and the research program planned for its initial phase of operation.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

TOWARDS ELETTRA 2.0: NEW CHALLENGES AND OPPORTUNITIES FOR SCIENCE AT CERIC

Lisa Vaccari,[1,*]

[1]*Elettra Sincrotrone Trieste, S.S. 14 Km 163.5, 34149, Trieste, Italy*

**E-mail:lisa.vaccari@elettra.eu*

After 30 years of supporting scientific research into the study of hard, soft and biological materials, Elettra synchrotron is undergoing a major upgrade, involving both the storage ring and its beamlines and laboratories. The improved brightness and coherence of Elettra 2.0 will make it possible to tackle scientific problems that could not have been solved before, thus opening up new avenues also in many research filed.

Elettra is presently experiencing a dark period, started from the second semester of 2025. Science continuity for both CERIC and Elettra users has been guaranteed by state-of-the-art offline facilities open to external users that offer cutting-edge bench-top instruments for vibrational spectroscopy, imaging, and X-ray Computed Tomography. The cryo-electron microscopy facility, which is currently undergoing commissioning, will be also added soon to the portfolio, for further strengthening the structural biology pipeline.

Here the status of Elettra 2.0 project and its implementation will be presented, highlighting the effort being made to create an energy-sustainable facility hosting an interconnected network of beamlines and offline facilities capable of looking at scientific topics in a holistic manner, integrating structural, morphological, chemical and dynamical information from the atomic to the total body level.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

SMALL-ANGLE SCATTERING AT TU GRAZ: FACILITIES AND SCIENTIFIC HIGHLIGHTS

H. Amenitsch[1]*, B. Sartori[1], B. Marmiroli[1], A. Radeticchio[1], S.Bernstorff[2], G.Smales[1], E.Afanasenko[3],A.Nagornyi[3], S.Klokic[1]

[1] *Graz University of Technology, Institute of Inorganic Chemistry, 8010 Graz, Austria*

[2] *Elettra-Sincrotrone Trieste, 34012 Basovizza (TS), Italy*

[3] *CERIC-ERIC, 34012 Basovizza (TS), Italy*

**E-mail: amenitsch@elettra.eu*

Small-angle scattering has become a standard technique for investigating nanomaterials with characteristic dimensions ranging from 1 nm to several micrometres using a variety of wavelengths and instruments, both laboratory-based and at large-scale research infrastructures.

This presentation will provide an overview of the experimental capabilities of TU Graz within the CERIC consortium. In addition, it will highlight selected scientific applications spanning fields from biophysics to energy materials. A common feature of these studies is the use of time-resolved and in situ approaches to investigate structural evolution under realistic operating conditions.

Finally, the presentation will discuss the new opportunities and capabilities that will become available with the ELETTRA 2.0 upgrade.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

NMR SPECTROSCOPY IN STRUCTURAL STUDIES

Janez Plavec,[1,2,3,*]

[1]*Slovenian NMR center, National Institute of Chemistry, Hajdrihova 19, Ljubljana*

[2]*University of Ljubljana, Faculty of Chemistry and Chemical Technology, Ljubljana*

[3]*EN-FIST Centre of Excellence, Ljubljana, Slovenia,*

**E-mail: janez.plavec@ki.si*

Nuclear Magnetic Resonance (NMR) spectroscopy is one of the most versatile and powerful analytical techniques available for the investigation of molecular systems. Its widespread application across chemistry, biology, materials science, and related disciplines stems from its unparalleled ability to provide detailed information on molecular structure, dynamics, and intermolecular interactions at the atomic level. NMR spectroscopy enables the identification and quantification of individual components in complex mixtures without the need for prior separation, making it an indispensable tool in diverse fields, including pharmaceutical sciences, metabolomics, food science, and chemical analysis. A distinguishing feature of NMR spectroscopy is its ability to investigate molecules in environments that closely resemble their native state, encompassing liquid- and solid-phase samples, as well as intact biological systems. Beyond structural elucidation, NMR provides unique insights into molecular dynamics, conformational equilibria, chemical exchange processes, and intermolecular interactions, thereby offering information that is frequently inaccessible by other analytical techniques. Furthermore, NMR spectroscopy continues to serve as a cornerstone of both fundamental scientific research and industrial applications, driving advances in molecular characterization, process development, and quality control.

Research at the Slovenian NMR centre focuses on the structural biology of nucleic acids, with particular emphasis on non-canonical DNA and RNA architectures, including G-quadruplexes. By combining advanced NMR spectroscopy with complementary biophysical techniques, our research aims to elucidate the three-dimensional structures, conformational dynamics, and folding mechanisms of these complex nucleic acid assemblies. This work is of considerable importance, as non-canonical nucleic acid structures play critical roles in gene regulation, genome stability, and other fundamental cellular processes, and are increasingly recognized as promising therapeutic targets. By advancing the understanding of their structural and functional properties, our research provides a foundation for the rational design of novel therapeutic strategies targeting these biologically significant molecular architectures.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

PRP@CERIC: AN INTEGRATED RESEARCH INFRASTRUCTURE FOR PATHOGEN RESEARCH INCLUDING ADVANCED GENOMICS, SINGLE-CELL MULTI-OMICS AND VIROLOGY UNIT

Federica Mantovani[1,*], Roberto Verardo[2], Giuditta De Lorenzo[3], Danilo Licastro[4], Stefano Cozzini[1]

[1] *Area Science Park, RIT Institute, Padriciano 99, Trieste, Italy*

[2] *Area Science Park, LAGE laboratory, Padriciano 99, Trieste, Italy*

[3] *Area Science Park, VIROLOGY Unit, Padriciano 99, Trieste, Italy*

[4] *Area Science Park, LAGE laboratory, Padriciano 99, Trieste, Italy*

**E-mail: federica.mantovani@areasciencepark.it corresponding/presenting author*

PRP@CERIC (Pathogen Readiness Platform for CERIC ERIC upgrade) is a distributed research infrastructure coordinated by Area Science Park within the framework of CERIC-ERIC. Supported by the Italian National Recovery and Resilience Plan (PNRR), it provides integrated access to advanced technologies for pathogen research through complementary platforms spanning structural biology, cryo-electron microscopy, advanced imaging and spectroscopy, high-resolution mass spectrometry, bioinformatics, high-performance computing and artificial intelligence. This multidisciplinary ecosystem enables comprehensive investigations of pathogens and host–pathogen interactions, from molecular mechanisms to systems-level analyses.

A major strength of PRP@CERIC is its Genomics and Transcriptomics Platform, which offers a comprehensive portfolio of next-generation sequencing technologies for both basic and translational research. The platform combines high-throughput short-read sequencing (Illumina NovaSeq) with long-read sequencing (Oxford Nanopore Technologies), supporting applications including whole-genome, whole-exome and targeted sequencing, RNA sequencing, metagenomics and microbial genomics. Dedicated bioinformatics pipelines enable genome assembly, variant detection, transcript isoform characterization and integrative multi-omics analyses.

Particular emphasis is placed on single-cell and spatial transcriptomics, providing single-cell RNA sequencing (scRNA-seq), immune profiling and spatially resolved transcriptomic analyses to investigate cellular heterogeneity, host–pathogen interactions and immune responses at unprecedented resolution. Integrated computational workflows support quality control, cell clustering, trajectory inference, cell-cell communication analyses and the integration of transcriptomic, proteomic and imaging datasets.

The Virology Unit at Area Science Park complements these capabilities through advanced experimental models for studying viral infections and antiviral strategies. The unit exploits viral replicon systems for functional studies and neutralization assays, together with cell-based infection models, viral propagation and titration, immunological assays, ELISA platform development and antiviral efficacy testing. In collaboration with ICGEB, additional studies on highly pathogenic viruses can also be supported. The close integration of virology with genomics and transcriptomics enables comprehensive investigations of viral evolution, host responses and pathogen–host interactions, supporting biomarker discovery, therapeutic target identification and translational research.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

THE CECOMEC PROJECT: CERIA-BASED COMPOUNDS AS EFFECTIVE CATALYST FOR ELECTROCHEMICAL CELLS

S. Amatori[1], K.Kujawska[2], M. Dominów[2], B. Bochentyn[2], K. Sowa[3], P. Korecki[3,4], F. D'acapito[5]

1 CERIC-ERIC, S. S. 14 - km 163,5 in AREA Science Park, Basovizza, Trieste, 34149, Italy

2 Faculty of Applied Physics and Mathematics, Gdansk University of Technology, Gdańsk, Poland

3 SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Kraków, Poland

4 Institute of Physics, Jagiellonian University, Kraków, Poland

5 CNR - Istituto Officina dei Materiali (IOM), Grenoble c/o ESRF, The European Synchrotron, Grenoble, France

*E-mail: simone.amatori@CERIC-ERIC.EU

Double-doped ceria materials have attracted considerable attention as potential anode catalytic layers for Solid Oxide Fuel Cells (SOFCs) thanks to their high oxygen ion conductivity, thermal stability and flexible redox properties. The CECOMEC project [1], funded by CERIC, aims to synthetize double-doped ceria systems and characterize dopant behavior to assess its influence on the microstructure and defect chemistry of these systems. A series of double doped ceria materials were synthesized using the Pechini method, a polyesterification method that enables fine control over cation homogeneity [2]. The dopants were selected from a lanthanide (La, Sm, Nd) and a transition metal (Fe, Co, Ni, Cu, Ru, Ag, Pt, Au) group. We focused on the characterization of the samples to understand their structure and physicochemical properties, and to understand how those relate to vacancy formation and ionic transport properties. The samples were subjected to a reduction step (pure H_2 at 900 °C) to assess their redox behavior and the stability of the resulting systems. A complete characterization was achieved across synchrotron radiation facilities (LISA@ESRF and POLYX@SOLARIS) and laboratories (TU-Gdańsk) alike, using complementary techniques such as XAS, XRD, μ-XRF, SEM, TPR/TPO and BET model and revealing distinct behaviors between dopant families. Lanthanide dopants substitute cerium in the fluorite lattice, generating vacancies without forming segregated secondary phases. In contrast, transition metals dopants exhibited different results, with most dopants showing a homogeneous dispersion of small oxide phases in the pristine sample which are then reduced during high-temperature treatment. In other cases, a metallic subphase formed in the pristine sample, indicating an early reduction and segregation during synthesis. The La-Fe co-doped sample displayed an intermediate behavior, with Fe in the +3-oxidation state without formation of a Fe oxide subphase. EXAFS analysis confirmed the successful insertion of Fe into the ceria lattice, which then undergoes exsolution to form metallic nanoparticles after the reduction treatment.

[1] https://cecomec.wordpress.com

[2] G. Rudisill et al., Chem. Mater., 2013, 25, 745 - 753

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

AI-DRIVEN AUTOMATION AND ASSISTANCE AT SYNCHROTRON FACILITIES

Maciej Jankowski,[1,*]
[1]*The European Synchrotron -ESRF, Grenoble, France*
**E-mail: maciej.jankowski@esrf.fr*

Large language models (LLMs) have rapidly evolved from novelties to everyday tools, and synchrotron facilities are now working to implement them. This contribution provides an overview of how AI is used at the ESRF, from general-purpose assistants available on-site to prototype agents that autonomously perform data analysis.

The ESRF operates a self-hosted chat platform that provides access to advanced language models and agentic capabilities on local infrastructure. This system enables staff and users to interact with AI tools for a broad range of scientific and operational tasks within the facility, including data exploration, technical support, and workflow automation. The platform supports both conversational chatbot interactions and agent-driven actions, such as interfacing with MCP servers and other facility resources, thereby facilitating seamless integration with existing computational environments and expanding user access to sophisticated digital assistance.

Moreover, at modern synchrotron beamlines, data volumes often exceed the capacity for manual analysis, especially for visiting researchers focused on science rather than technical details. The goal is to move beyond chat-based assistance by deploying autonomous agents that run data-analysis workflows with existing computational tools, present results through interactive interfaces, and streamline routine tasks.

The integration of language model assistants and autonomous agents is reshaping workflows and expanding scientific opportunities at synchrotron facilities. These AI-driven tools accelerate data processing and enable innovative analytical methods. Future efforts will focus on scaling these technologies, deepening integration with facility systems, and addressing adoption and interoperability challenges. This work highlights the opportunities AI presents at the ESRF and outlines priorities for its continued development within facility operations.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ARYA – NEW BEAMLINE FOR MACROMOLECULAR X-RAY CRYSTALLOGRAPHY AT SOLARIS NSRC

Michal Gucwa,[1] Joanna Sławek*,[1] Marcin Jaciuk,[1] Tomasz Kołodziej,[1] and Maciej Kozak[1]
[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Kraków, Poland*
*E-mail: joanna.slawek@uj.edu.pl**

ARYA (m**A**cromolecula**R** x-ra**Y** cryst**A**llography beamline, formerly SOLCRYS) is Poland's first dedicated macromolecular crystallography beamline, under construction at SOLARIS NSRC. Thanks to advanced hardware and sophisticated beamline control and data-processing software, the measurement process will be fully automated, enabling data collection from hundreds of crystals per day. The tunable energy range (4–22 keV) will support SAD and MAD phasing experiments, allowing straightforward identification of metal ions in macromolecular structures via their anomalous scattering signal. Beyond structural biology applications on proteins, the beamline will also serve chemistry users studying small-molecule ligands and organic and inorganic crystals.

The infrastructure plan has been finalized, and we are awaiting installation of the key beamline components on site. Once installed and commissioned, they will be operated from a dedicated, comfortable control room, built to support on-site data collection around the clock.

We're working on integrating a Laboratory Information Management System (LIMS) based on ISPyB with the MXCuBE beamline control software, enabling remote data collection and straightforward retrieval of collected datasets. Dedicated computing infrastructure, combined with automated data-processing pipelines, will allow rapid determination of optimal data-collection strategies as well as automated crystal centering, enabling a fully automated workflow and fast turnaround time for single data collections.

On-site MX experiments will be supported by a dedicated biochemistry, biology, and sample-preparation laboratory, allowing users to respond dynamically to experimental results and set up new crystallization trials on-site to identify optimal diffracting conditions in real time. The laboratory will be equipped with a range of biochemical characterization and crystallization instrumentation.

Following installation and commissioning of the beamline components and control software, ARYA is on track to welcome its first users in early 2028. The beamline will then be opened to the structural biology and chemistry communities for both on-site and remote data collection, offering high-throughput, fully automated crystallographic screening and data collection to academic and industrial users across Poland, Europe and beyond.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

FROM SELF-ASSEMBLY TO DELIVERY: RCNMV VIRUS-LIKE PARTICLES AS BIOCOMPATIBLE RNA NANOCARRIERS

Martyna Kordyś[1]‡, Joanna Śliwiak[1]‡, Artur Biela[2], Miłosz Ruszkowski[1], Agata Swiatkowska[1], Anna Urbanowicz[1*]

[1]*Institute of Bioorganic Chemistry, Polish Academy of Sciences, 61-704 Poznań, Poland*

[2] *SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Krakow, Poland*

‡ *The authors contributed equally*

**E-mail:* aniau@ibch.poznan.pl

Virus-like particles (VLPs) are nanoscale protein shells that mimic the structure of viruses but lack infectious genetic material, making them safe and versatile platforms for biomedical applications. Their ability to encapsulate cargo and their amenability to genetic and chemical engineering make them promising candidates for targeted drug delivery, including RNA-based therapeutics. However, the molecular mechanisms governing VLP assembly and RNA encapsidation remain poorly understood, limiting the rational design and optimization of VLP-based delivery systems.

To address this challenge, we created an experimental system based on VLPs composed of recombinant capsid protein (rCP) derived from the Red Clover Necrotic Mosaic Virus (RCNMV), an icosahedral $T = 3$ plant RNA virus. To comprehensively characterize VLP self-assembly process and optimize the RNA cargo encapsidation protocol, we combine biophysical approach including light scattering techniques, mass photometry, and cryo-electron microscopy, with biological approach relying on transfection of mammalian cell cultures.

We systematically investigate the effects of rCP protein concentration, buffer composition, and cargo properties on VLP formation, with particular emphasis on identifying and describing the self-assembly pathways and determining the conditions that promote efficient cargo encapsidation. Our approach to date has enabled the production of VLPs capable of delivering siRNA to mammalian cells, resulting in significant gene expression silencing, while having no adverse effect on cell culture viability.

Our findings will facilitate the rational design of plant virus-derived VLPs as effective and biocompatible RNA delivery platforms and contribute to the development of next-generation nucleic acid delivery technologies.

The research was supported by the Medical Research Agency grant no. ABM/2021/5/00004

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

WHAT IS HIDING IN THE CRYOEM MAPS: FITTING GLYCAN CONFORMATIONAL ENSEMBLES TO DENSITY MAPS

Karolina Mitusińska[1,*] and Mateusz Sikora[1]

[1]*Dioscuri Centre for Modelling of Posttranslational Modifications, Malopolska Centre of Biotechnology, Jagiellonian University, 30-387 Cracow, Poland*

**E-mail: karolina.mitusinska@uj.edu.pl*

Post-translational modification is a covalent alteration of the protein structure occurring during or after protein synthesis, usually by adding or removing functional groups, typically impacting the protein function. Glycosylation is one of the richest and most diverse modifications, due to the complex, partially stochastic biosynthesis, and sheer size of the glycans. Glycans sculpt protein surfaces to aid folding, protect proteins from degradation, and act as a self "ID tags" that shape immune recognition and surveillance. They support antibody folding and stability and modulate interactions with antigens and immune receptors. Moreover, alterations and deficiencies in glycosylation are correlated with various diseases, including cancer, diabetes, and autoimmunological disorders, where glycans are useful diagnostic markers. Due to the numerous monosaccharide types and a multitude of possible linkages between the monosaccharides, glycans display high conformational flexibility and compositional heterogeneity.

Experimental methods for solving protein structures, such as X-ray crystallography or single particle cryo-electron microscopy (cryoEM), rely on ensemble averaging. Therefore, such flexible and conformationally diverse compounds as glycans on the protein surface are often lost during the image processing stages. Moreover, in some structural studies, glycans are enzymatically removed to reduce sample heterogeneity or facilitate crystallization.

In this project we aim to resolve the missing structural information on glycans and their spatial distribution by incorporating glycan conformational ensembles into protein structures, moving beyond static protein-only models toward ensemble-refined Protein Data Bank (PDB) entries that better support downstream machine learning applications. This will allow us to quantify how glycan dynamics reshape protein structure and to integrate these effects into models that better capture the native conformational landscape of glycoproteins.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

STRUCTURAL BIOLOGY AT THE MAŁOPOLSKA CENTRE OF BIOTECHNOLOGY: EMPOWERING DRUG DISCOVERY THROUGH X-RAY CRYSTALLOGRAPHY AND BEYOND

Piotr Wilk[1,*] Klaudia Woś[1], Elżbieta Wątor-Wilk[2] and Przemysław Grudnik[1]
[1]*Małopolska Centre of Biotechnology, Jagiellonian University, Kraków, Poland*
[2]*Institue of Catalysis and Surface Chemistry, Polish Academy of Sciences, Kraków, Poland*
**E-mail: wilk.piotr@uj.edu.pl*

The Structural Biology Core Facility (SBCF) at the Małopolska Centre of Biotechnology (MCB) serves as a key hub for structural research, providing essential support for high-impact drug discovery and mechanistic studies. Our history is intrinsically linked with the development of research infrastructure at Solaris; the SBCF played a foundational role in the establishment of the local cryo-EM facility. While we continue to facilitate cryo-EM projects through established collaborations, our current operations primarily focus on state-of-the-art X-ray crystallography, leveraging the high-throughput capabilities of modern synchrotrons.

Our facility's expertise is best exemplified by two recent, successful collaborations. First, in a campaign of crystallographic fragment screening on human deoxyhypusine synthase (DHS), we identified potential inhibitors of this rate-limiting enzyme in the hypusination pathway. With an unprecedented hit rate, this study revealed novel binding clusters at the active site, the regulatory ball-and-chain motif, and allosteric regions at the tetramer interface.

Second, in a collaborative effort with Molecure and the Medical University of Warsaw, our facility provided critical structural analysis to support the development of selective USP7 inhibitors. By delivering detailed insights into inhibitor binding modes, we facilitated the SAR-driven optimization of the lead compound, OAT-4828. This potent inhibitor enhances T-cell killing capacity and demonstrates significant antileukemic activity in vivo, validating USP7 inhibition as a powerful approach for modulating the p53–MDM2 axis.

Moving forward, the SBCF aims to further evolve its structural biology pipeline. As we continue to bridge the gap between fundamental research and therapeutic application, we look forward to sharing our experiences in structural studies with the team of the forthcoming Arya beamline, a dedicated crystallography beamline currently under development at the SOLARIS National Synchrotron Radiation Centre.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

TOWARDS THREE-DIMENSIONAL MOLECULAR ORIENTATION MAPPING WITH FOUR-POLARIZATION AFM-IR

Karolina Kosowska,[1]* Kaja Piana,[1] Julia Chudzik,[1] and Tomasz P. Wróbel[1]
[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*
**E-mail karolina.kosowska@uj.edu.pl*

The four-polarization (4P) method is based on the principle that linearly polarized infrared light selectively excites molecular vibrations when the transition dipole moment is aligned with the polarization direction of the incident radiation [1]. Simultaneous analysis of two non-parallel transition dipole moments enables determination of molecular orientation in three-dimensional space (4P-3D). Our group has previously demonstrated the applicability of this approach using FTIR microscopy and, subsequently, Optical Photothermal Infrared (O-PTIR) spectroscopy, revealing the three-dimensional macromolecular organization of structures in poly(L-lactic acid) (PLLA) spherulites with improved spatial resolution [2].

To further advance this approach, we extend the four-polarization methodology to Atomic Force Microscopy – Infrared Spectroscopy (AFM-IR). AFM-IR provides chemical information with spatial resolution determined by the AFM tip, reaching < 20 nm [3]. Since the quantum cascade laser (QCL) used in AFM-IR is intrinsically linearly polarized, the 4P-3D method can be conveniently implemented while taking advantage of the significantly improved spatial resolution.

To enable polarization-dependent measurements, the Neaspec microscope installed at the CIRI Beamline of the SOLARIS National Synchrotron Radiation Centre was modified by incorporating a half-wave plate and a wire-grid polarizer into the QCL optical path. This configuration allows precise control of the incident polarization state while suppressing unwanted polarization components. Preliminary results obtained for PLLA spherulite and other polymer systems demonstrate the feasibility of the proposed approach and its potential for nanoscale three-dimensional orientation analysis.

[1] LeeYoung Jong, *Journal of the Optical Society of America A,* 42(2) 102 (2025)
[2] Karolina Kosowska, et al., *Analytical Chemistry*, 98(13), 9776 (2026)
[3] Alexandre Dazzi and Craig B. Prater, *Chemical Reviews*, 117(7), 5146 (2017)

This research was supported by the National Science Centre, Poland (SONATINA 7, "Study of the effect of modifiers on the crystallization process of thermoplastic polymers: polarized IR microscopy below the diffraction limit", Grant. No. 2023/48/C/ST4/00176).

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

DECODING CHAIN ORIENTATION AND NANOSCALE HETEROGENEITY IN POLYMERS VIA POLARIZED O-PTIR MICROSCOPY

Karolina Kosowska,[1,*] Honorata Oleś,[1,2] and Tomasz P. Wrobel[1]

[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*

[2]*Doctoral School of Exact and Natural Sciences, Jagiellonian University, 30-348 Kraków, Poland*

**E-mail: karolina.kosowska@uj.edu.pl*

In recent years, optical photothermal microscopy (O-PTIR) has been gaining popularity in biological[1] and materials research[2]. It simultaneously provides mid-infrared and Raman spectra. Because spatial resolution depends on the visible probe, it is wavelength-independent and up to several dozen times greater than FT-IR microscopy[3].

The phenomenon of IR absorption dependence on polarization angle and orientation function distribution algorithm (ODF) can be successfully used to determine the orientation of molecules in 3D space[4-6]. Using O-PTIR microscopy, we have obtained information on molecular organization in a semi-crystalline polymer with submicron resolution[5-6], entering a field dominated by X-ray methods. We investigated the effect of plasticizers and nano-nucleators on the molecular organization in poly(L-lactic acid). The new method not only provides high resolution but is also sensitive to subtle changes in morphological organization, such as changes in lamella angle in space.

This research was supported by the National Science Centre, Poland (SONATINA 7, Grant No. 2023/48/C/ST4/00176). O-PTIR and FT-IR measurements were performed at the CIRI beamline under the provision of the Polish Ministry and Higher Education project Support with the use of research infrastructure of the NCPS SOLARIS under contract nr 1/SOL/2021/2.

Bibliography

1. Gajjela, C. C. et al. Analyst 2023, 148, 2699–2708.
2. Böke, J. S.; Popp, J.; Krafft, C. Sci. Rep. 2022, 12, 18785.
3. Prater, C. B.; Kansiz, M.; Cheng. APL Photonics 2024, 9, 091101.
4. Lee, Y. J. Opt. Express. 2018, 26, 24577 .
5. Koziol, P.; Kosowska, K. et al. Am. Chem. Soc. 2022, 144, 14278–14287.
6. Kosowska, K.; Oleś, H; Wrobel, T. P. Anal. Chem. 2026, 98, 13, 9776–9786.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

CUTICULAR WAX COMPOSITION AND RYE RESISTANCE TO LEAF RUST: PRELIMINARY RESULTS SUPPORTING SYNCHROTRON-BASED CHEMICAL IMAGING

Joanna Szewińska,[1,*] Magdalena Święcicka,[1] Barbara Nasiłowska,[2] Ewa Papierowska[1]
[1] *Warsaw University of Life Sciences-SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland*
[2] *Military University of Technology, gen. S. Kaliskiego 2, 00-908 Warsaw, Poland*
**E-mail: joanna_szewinska@sggw.edu.pl*

Rye (*Secale cereale* L.) is an important cereal crop in Central and Eastern Europe, valued for its tolerance to environmental stresses. However, its productivity is considerably affected by leaf rust caused by *Puccinia recondita* f. sp. *secalis* (*Prs*). Understanding the mechanisms underlying host resistance is therefore of great agronomic importance.

To investigate the role of the leaf cuticle in resistance, we analysed two rye inbred lines differing in their response to *Prs* 72/17/2.5: the resistant line SE133 (infection type 0 according to the 6-point Murphy scale) and the susceptible line L318 (infection type 4). RT-qPCR analysis revealed significant differences in the expression of *ScGL1-3* and *ScGL1-5*, genes encoding key enzymes involved in epicuticular wax biosynthesis, following pathogen inoculation. Scanning electron microscopy (SEM) further demonstrated abundant urediniospore germination, well-developed germ tubes, and appressorium formation on leaves of the susceptible line L318, whereas these infection structures were absent or strongly reduced on the resistant line SE133.

These preliminary findings indicate that the physicochemical properties of the leaf surface, particularly the composition and organization of cuticular waxes, may contribute to resistance against leaf rust. To verify this hypothesis, we will perform high-resolution chemical imaging of inoculated and non-inoculated leaves from resistant and susceptible genotypes using optical photothermal infrared (O-PTIR) spectroscopy at the CIRI beamline of the SOLARIS National Synchrotron Radiation Centre. This approach will enable spatially resolved characterisation of cuticular wax composition at the microscale and provide new insights into the role of the cuticle in plant–pathogen interactions.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

SYNCHROTRON X-RAY FLUORESCENCE IMAGING AND QUANTIFICATION OF ELEMENTAL COMPOSITION IN THE RODENT CEREBELLUM: OBESITY-INDUCED CHANGES

Wiktoria Tokarczyk [(1)], Agata Ziomber-Lisiak[(2)], Pawel Wrobel[(1,4)], Blazej Ruszczycki[(1)], Aleksandra Chenczke [(1,3)], Patryk Stec[(1)], Filip J. Baran[(4,5)], Katarzyna M. Sowa[(4)] and Magdalena Szczerbowska-Boruchowska [(1)]

(1) Faculty of Physics and Applied Computer Science, AGH University of Krakow, Krakow, Poland.

(2) Faculty of Medicine, Jagiellonian University Medical College, Krakow, Poland.

(3) Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering, AGH University of Krakow, Krakow, Poland.

(4) SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Krakow, Poland.

(5) Doctoral School of Exact and Natural Sciences, Jagiellonian University, Krakow, Poland

Obesity is a complex, multifactorial disease with far-reaching consequences that extend beyond physical health to encompass psychological, social, and economic dimensions. It is associated with increased morbidity and mortality, representing a major global public health challenge. In the context of eating cerebellum is not only responsible for motor functions such as chewing or swallowing, but also for homeostatic, reward related aspects of food intake. In this research we wanted to asset whether early stage obesity and reported by literature morphological changes associated with it alter the elemental composition of the cerebellum. This study utilized tissues form male Wistar rats. Animals were separated into two groups, the obese one was fed high-calorie diet, while the control group received standard diet. From each cerebellum two slices were cryo-sectioned - one from anterior side and one from the posterior side. Synchrotron radiation based X-ray fluorescence (SRXRF) microimaging was used for the topographic and quantitative analysis of P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, which are the elements responsible, among other things, for enzymatic activity and energy metabolism. The experiment was carried out at the PolyX beamline at SOLARIS National Synchrotron Radiation Centre in Krakow. A monochromatic excitation beam with an energy of 10 keV and the spot size of 30 μm was applied. The acquired XRF spectra were used to determine elemental distribution and quantify elemental concentrations using the external standard method. Additionally, a dedicated data selection approach was developed to facilitate the analysis of distinct cerebellar structures, accounting for the complex morphology of the cerebellum. Although no statistically significant differences in concentrations were found for individual elements, PCA analysis showed that the overall elemental profile of the cerebellum separated the obese group from the lean group very well. Furthermore, we have demonstrated that the SRXRF microanalysis, supported by surface data extraction methods, may provide a valuable approach for topographic and quantitative analysis of a wide range of chemical elements in morphologically complex tissues.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

TRACKING STAGE-SPECIFIC PHOSPHORUS TRANSFORMATIONS DURING HIGH-CELL-DENSITY MCL-PHA PRODUCTION BY PSEUDOMONAS PUTIDA KT2440 USING P K-EDGE XANES

Katarzyna Zimowska[1]*, Anna Faruga[1], Maciej Guzik[1], Justyna Prajsnar[1], Robert Karcz[1], Joanna Kryściak-Czerwenka[1], Ewelina Cichoń[1], Alexey Maximenko[2]

[1]*Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, 30-239 Kraków, Poland*

[2]*National Synchrotron Radiation Centre SOLARIS Jagiellonian University 30-392 Kraków, Poland*

**E-mail: katarzyna.zimowska@ikifp.edu.pl*

Phosphorus is an important nutrient governing microbial growth, yet its chemical speciation during industrial-scale bioprocesses remain poorly understood. In *Pseudomonas putida* KT2440, a promising microbial cell factory for medium-chain-length polyhydroxyalkanoate (mcl-PHA) production, phosphorus metabolism is closely linked to physiological adaptation throughout high-cell-density fed-batch cultivation. Understanding these transformations is therefore crucial for improving process performance and polymer productivity. In this study, we investigated phosphorus dynamics during PHN production by integrating synchrotron-based P K-edge X-ray Absorption Near Edge Structure (XANES) spectroscopy. Samples collected at three representative stages of fermentation - early exponential growth, the transition to intensive polymer accumulation, and the late production phase - were analyzed to capture the temporal evolution of phosphorus metabolism. P K-edge XANES spectra were interpreted by linear combination fitting using an extensive reference library comprising inorganic phosphates ($Na_2HPO_4xH_2O$, $NaH_2PO_4xH_2O$, K_2HPO_4, KH_2PO_4), polyphosphates, nucleotides (ATP, ADP, GDP, dNTPs, NADH), phosphoenolpyruvate, phosphoethanolamine, glucose-6-phosphate, fructose-1,6-bisphosphate, phospholipids, DNA and iron phosphate ($FePO_4$) standards. This approach enabled semi-quantitative identification of inorganic and organic phosphorus species throughout the process. This work demonstrates the potential of employing synchrotron spectroscopy for real-time process analytics and offers a comprehensive framework for understanding phosphorus metabolism in industrial microbial fermentations. The presented approach provides new opportunities for rational optimization of mcl-PHA bioprocesses through improved control of phosphorus utilization.

Acknowledgements: Grant: National Synchrotron Radiation Centre SOLARIS Jagiellonian University, Proposal No.: 232047, ASTRA beamline.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ASTRA AT THE SOLARIS SYNCHROTRON: A VERSATILE TENDER X-RAY ABSORPTION SPECTROSCOPY BEAMLINE

Lulu Alluhaibi[1]*, Alexey Maximenko[1], Grzegorz Gazdowicz[1], Marcin Brzyski[1], Marcel Piszak[1], Henning Lichtenberg[2], Josef Hormes[3,5], and Alexander Prange[4,5]

[1]*SOLARIS National Synchrotron Radiation Centre, Kraków, Poland*

[2]*Hochschule Niederrhein University of Applied Sciences, Krefeld, Germany*

[3]*Institute of Physics, Rheinische Friedrich-Wilhelms-Universität, Bonn, Germany*

[4]*South Westphalia University of Applied Sciences, Soest, Germany*

[5]*Center for Advanced Microstructures and Devices, Louisiana State University, USA*

**E-mail: lulu.alluhaibi@uj.edu.pl*

The poster will present an overview of the ASTRA beamline at the SOLARIS National Synchrotron Radiation Centre and highlight its broad research applications through selected experimental results. ASTRA (Absorption Spectroscopy beamline for Tender energy Range and Above) is a bending-magnet beamline dedicated to X-ray Absorption Spectroscopy (XAS). The beamline operates in the 1–15 keV photon energy range (optimized for 1.8–12 keV), covering both tender and hard X-ray energies. This energy range makes ASTRA particularly well suited for investigating the chemical environment of light elements using XANES (X-ray Absorption Near Edge Structure) and EXAFS (Extended X-ray Absorption Fine Structure) spectroscopy[1]

ASTRA offers several advanced experimental capabilities. An integrated X-ray camera enables precise sample positioning, improving measurement accuracy, reproducibility, and data quality. A variety of sample environments are routinely available, including liquid cells, electrochemical cells, catalytic and photocatalytic reactors, and inert-atmosphere setups. In addition, a Raman microscope allows combined XAS–Raman measurements, providing complementary structural and chemical information for comprehensive materials characterization. The versatility of ASTRA is demonstrated through research applications across multiple scientific disciplines, including energy storage, catalysis and electrocatalysis, materials science, biology, environmental science, archaeology, Earth sciences, and mineralogy.

Acknowledgements: The measurements at ASTRA are supported under the Polish Ministry and Higher Education project: “Support for research and development with the use of research infrastructure of the National Synchrotron Radiation Center SOLARIS” under contract nr 1/SOL/2021/2. The further development of the ASTRA beamline for measurements at low photon energies was supported within the EU Horizon2020 program (952148-Sylinda).

[1] J. Hormes, W. Klysubun, J. Gottert, et al., *Nucl. Instrum. Methods Phys. Res. B*, 2021, **489**, 76-81

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

SULFUR COMPOUND CYCLING DURING HIGH-CELL-DENSITY FERMENTATION OF PSEUDOMONAS PUTIDA KT2440 MONITORED BY S K-EDGE XANES SPECTROSCOPY

Anna Faruga,[1,] Katarzyna Zimowska[1], Justyna Prajsnar[1], Maciej Guzik[1], Robert Karcz[1], Joanna Kryściak-Czerwenka[1], Ewelina Cichoń[1], Aleksiej Maksimenko[2]*

1 Jerzy Haber Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences in Cracow

2 National Synchrotron Radiation Centre SOLARIS Jagiellonian University

**E-mail: anna.faruga@ikifp.edu.pl*

Sulfur is an essential element in microbial metabolism, playing a crucial role in the biosynthesis of sulfur-containing amino acids, the assembly of iron–sulfur (Fe–S) clusters, the maintenance of cellular redox homeostasis, and the activity of numerous enzymes. Despite its fundamental biological importance, dynamic changes in sulfur speciation during industrial high-cell-density (HCD) fermentations remain poorly understood. The aim of this study was to investigate changes in the chemical forms of sulfur during the fermentation of *Pseudomonas putida* KT2440, a well-established producer of medium-chain-length polyhydroxyalkanoates (mcl-PHA) from nonanoic acid, using sulfur K-edge X-ray Absorption Near Edge Structure (S K-edge XANES) spectroscopy. To facilitate the interpretation of biological XANES spectra, a reference library of sulfur-containing compounds was established, comprising biologically relevant species representing a range of chemical environments and oxidation states. The library included inorganic metal sulfates ($MnSO_4 \cdot H_2O$, $CuSO_4 \cdot 7H_2O$, $MgSO_4 \cdot 7H_2O$, $ZnSO_4 \cdot 7H_2O$, and $FeSO_4 \cdot 7H_2O$), ammonium sulfate, sodium thiosulfate, and organic sulfur compounds, including cysteine, methionine, reduced and oxidized glutathione, coenzyme A, and thiamine. These reference spectra were used to interpret the spectra of biological samples and to identify the predominant sulfur species present during fermentation. Biomass samples collected at three representative stages of the fermentation process—the initial growth phase, the metabolic transition phase, and the final stage of intensive biopolymer accumulation—were analyzed. Comparison of the S K-edge XANES spectra revealed temporal changes in sulfur speciation, indicating dynamic remodeling of sulfur metabolism accompanying the transition from active cell growth to carbon storage in the form of mcl-PHA. These results demonstrate that S K-edge XANES spectroscopy, supported by a comprehensive library of sulfur reference compounds, is a powerful tool for monitoring sulfur speciation in complex biological systems. This approach provides new insights into sulfur metabolism during industrial fermentation and offers valuable information for the optimization and control of microbial bioprocesses.

Grant: SOLARIS Proposal No. 232047 (ASTRA beamline).

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

BEYOND ACADEMIC BEAMTIME: INDUSTRIAL ACCESS TO THE SOLARIS SYNCHROTRON

Mikołaj Gołuński,[1,*]
[1]*NCPS SOLARIS, Jagiellonian University, ul. Czerwone Maki 98, 30-392 Kraków, Poland*
**E-mail: mikolaj.golunski@uj.edu.pl*

The National Synchrotron Radiation Centre SOLARIS is a large-scale research infrastructure providing access to synchrotron radiation for more than 700 scientists annually. The majority of users access the facility through a competitive peer-reviewed beamtime allocation system, which offers free access for research projects intended for publication. In this mode, scientific excellence and the expected impact of the proposed research constitute the primary evaluation criteria.

Alongside the academic access programme, SOLARIS offers an industrial access scheme designed for research and development activities requiring a higher level of confidentiality and operational flexibility. Despite its name, this mode is not restricted to industrial companies and may be used by any organisation or individual willing to cover the cost of beamtime and associated services.

Industrial access is particularly attractive for projects involving proprietary information, intellectual property protection, product development, process optimisation, troubleshooting, quality control, or preparation of patent applications. In contrast to many academic investigations driven primarily by scientific curiosity, industrial projects are often motivated by specific technological challenges and market needs. This mode also enables access to advanced analytical techniques without the constraints associated with competitive proposal calls and publication requirements.

This contribution presents the industrial access scheme available at SOLARIS, including its operational framework, access procedures, available services, and opportunities for collaboration with external partners. Selected examples of industrial research performed at SOLARIS will be discussed to illustrate the broad spectrum of scientific and technological problems that can be addressed using synchrotron radiation techniques. The presentation will also highlight the role of synchrotron facilities in supporting innovation and strengthening cooperation between academia and industry.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

OPERANDO XAS STUDY OF THE EVOLUTION OF MANGANESE OXIDATION STATE IN A MODEL HETEROGENEOUS CATALYST, CRYPTOMELANE (K-OMS-2)

Karol Górecki [1,2,*], Anna Wach[3], Michał Śliwa[3], Zbigniew Sojka[1], Joanna Gryboś[1]
[1] *Faculty of Chemistry, Jagiellonian University (JU), Gronostajowa 2, Kraków, Poland*
[2] *Doctoral School of Exact and Natural Sciences, JU, Łojasiewicza 11, Kraków, Poland*
[3] *National Synchrotron Radiation Centre SOLARIS, JU, Czerwone Maki 98, Kraków, Poland*
** E-mail: gorecki@chemia.uj.edu.pl*

Catalysts are essential for sustaining the perpetual development of our society, as they enable crucial reactions under attainable conditions through modifications to the mechanisms. Transition-metal oxides constitute a large class of heterogeneous catalysts widely used in processes involving reversible redox reactions, including energy storage, fuel production, and environmental remediation. Among them, manganese oxides attract particular attention due to their environmental benignness, abundance, and ability to attain multiple oxidation states. This redox flexibility arises from the possibility of $Mn^{2+}/Mn^{3+}/Mn^{4+}$ species coexistence, which can be tuned through structural modifications or promoted by alien cation incorporation [1].

Among these materials, aliovalent tunnel-structured manganese oxides represent an important class – hollandite-type $K_xMn_8O_{16}$ (cryptomelane, K-OMS-2) is particularly attractive, as its framework of MnO_6 octahedra forms one-dimensional tunnels stabilised by alkali cations, enabling oxygen exchange and mixed valence. X-ray absorption spectroscopy at the PolyX beamline of NSRC Solaris was employed at the Mn *K* edge to study the bonding around manganese atoms via EXAFS analysis, and XANES was applied for determining the manganese average oxidation state (AOS). Using an array of reference compounds, a linear relation was established between AOS and the inflection point position, allowing for a facile determination of Mn AOS from XANES spectra. Using a proprietary capillary setup, *operando* XAS experiments were performed to study the evolution of manganese speciation during the reduction (in inert gas by a thermal stimulus and in H_2) and reoxidation (using O_2) reactions. Temperatures of certain AOS regimes were determined, providing an important step in the determination of the mechanisms of reversible redox thermochemical processes.

[1] Gryboś, J; et al. ACS Catal. 2021, 11 (15), 9530–9546.

Acknowledgements
The research is carried out within the OPUS 25 project (grant number 2023/49/B/ST4/00740, PI: Dr Joanna Gryboś), funded by NCN, the Polish National Science Centre. Measurements at the National Synchrotron Radiation Centre SOLARIS were supported by the Ministry of Science and Higher Education, Poland, under contract no. 1/SOL/2021/2.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

HARNESSING SYNCHROTRON RADIATION FOR ENHANCED EXSOLUTION PROCESSES IN NOBLE METAL CATALYSIS

Michał Dominów[1], Beata Bochentyn[1], Agnieszka Witkowska[1], and Jakub Karczewski[1,*]
[1]*Faculty of Applied Physics and Mathematics, Gdansk University of Technology, 80-233 Gdańsk, ul. Narutowicza 11/12 Poland*
**E-mail: jakub.karczewski@pg.edu.pl*

The transformative role of synchrotron radiation in advancing the understanding of exsolution processes in noble metal catalysis was explored in this presentation. A model system of $(La_{0.3}Sr_{0.7})_{0.9}Ti_{1-x}M_xO_{3+\delta}$, where M represented various noble metals, was investigated to determine how different metal dopants influenced catalytic performance during reactions such as dry methane reforming. It was indicated that optimal doping levels significantly enhanced both activity and stability, enabling effective CO_2 and CH_4 conversions. Synchrotron X-ray photoelectron spectroscopy (XPS) was utilized to uncover the intricate relationships between metal-support interactions and the oxidation states of noble metals, revealing their crucial role in promoting catalytic efficiency. The unique capabilities of synchrotron radiation provided high-resolution insights into the electronic and structural properties of catalytic materials, facilitating a deeper understanding of complex reaction mechanisms. Such precision in analysis allowed for the identification of subtle changes in oxidation states and surface chemistry that were pivotal for optimizing catalytic performance. These insights paved the way for the optimization of catalytic systems through tailored exsolution strategies for various noble metals. This research addressed critical environmental challenges by improving methane reforming processes, with potential implications for sustainable energy solutions.

Acknowledgements

This work was supported by the National Science Center under grant No. 2021/42/E/ST5/00450.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

TOPOTACTIC ION EXCHANGE EXSOLUTION IN $(La,Sr)_{0.9}(Co,Fe,Ti)O_3$: A SYNCHROTRON-BASED STUDY

Kinga Kujawska,[1,*] Michał Dominów,[1] Jakub Zdankiewicz,[1] Wiktoria Kąkol,[1] Agnieszka Witkowska,[1] Jakub Karczewski,[1] Beata Bochentyn,[1]

[1] *Advanced Materials Centre, Faculty of Applied Physics and Mathematics, Gdansk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland*

**E-mail:* kinga.kujawska@pg.edu.pl

Modern materials engineering plays a key role in advanced energy technologies by enabling the design of materials with specific structural and functional properties. In the context of Solid Oxide Fuel Cells (SOFCs), electrode materials engineering is critical for enhancing catalytic activity, long-term stability, and fuel flexibility. Achieving these objectives requires both the synthesis of novel materials and a comprehensive understanding of the structural and chemical changes that occur within them. Such information can be obtained using advanced characterization techniques, with synchrotron radiation. This study investigates perovskite oxides of composition $(La,Sr)_{0.9}(Co,Fe,Ti)O_3$ to evaluate the possibility of topotactic ion exchange exsolution. In this approach, cobalt is integrated into the perovskite lattice, while iron is introduced onto the material surface via sputtering, ball milling, or solution impregnation. Upon reduction, surface iron and lattice cobalt are expected to exchange positions, resulting in the formation of catalytically active nanoparticles and potentially Co-Fe alloy nanoparticles. The synthesized materials were characterized at the SOLARIS National Synchrotron Radiation Centre using three complementary beamlines. Scanning Transmission X-ray Microscopy at the DEMETER beamline facilitated chemical mapping of individual nanoparticles with an average size of approximately 50 nm. X-ray Photoelectron Spectroscopy and X-ray Absorption Spectroscopy at the PHELIX beamline yielded information on the oxidation states and chemical environments of cobalt and iron. Additional XAS measurements, including XANES and EXAFS analyses at the ASTRA beamline, enabled determination of the local atomic structure surrounding Co and Fe atoms. Collectively, these techniques provided unattainable insights through conventional laboratory methods.

The results offer new insights into the topotactic ion exchange exsolution mechanism. This study demonstrates that access to multiple synchrotron techniques within a single research infrastructure enables comprehensive characterization of complex functional materials. It also highlights the crucial role of the SOLARIS synchrotron in advancing materials engineering research.

Acknowledgements: This work was supported by the National Science Centre under grant No. 2021/42/E/ST5/00450 entitled “Tailoring multicomponent nanometric alloys formed on active support for designing the stable anodes of Solid Oxide Fuel Cells”.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

The electronic structure of 1D Pd@Ni nanospikes and their electrochemical activity in oxidation of ethanol

Dariusz Łukowiec [1], Tomasz Wasiak[2], Dawid Janas[3], Joanna Depciuch[4], Jerzy Kubacki[5], Stanisław Wacławek[6], Adrian Radoń [7] and Alexey Maximenko[8]

[1] *Materials Research Laboratory, Faculty of Mechanical Engineering, Silesian University of Technology, Konarskiego 18A St., 44-100 Gliwice, Poland*

[2] *Institute of Chemistry, University of Silesia in Katowice, Szkolna 9 St., 40-006 100 Katowice, Poland*

[3] *Faculty of Chemistry, Silesian University of Technology, B. Krzywoustego 4 St., 44-100 Gliwice, Poland*

[4] *Institute of Nuclear Physics Polish Academy of Sciences, Radzikowskiego 152 St., 31-342 Krakow, Poland*

[5] *Faculty of Science and Technology, Institute of Physics, University of Silesia in Katowice, 75 Pułku Piechoty 1, 41-500 Chorzów, Poland*

[6] *Institute for Nanomaterials, Advanced Technologies and Innovation, Technical University of Liberec, Studentská 1402/2, 461 17 Liberec 1, Czech Republic*

[7] *Departament of Engineering Materials and Biomaterials, Faculty of Mechanical Engineering, Silesian University of Technology, Konarskiego 18A St., 44-100 Gliwice, Poland*

[8] *SOLARIS National Synchrotron Radiation Centre, 30-392, Kraków, Poland*

Email: dariusz.lukowiec@polsl.pl

The world's sustained high demand for electricity requires the development of ever more efficient, cost-conscious catalysts for its production. Among the many catalysts based on Pd, combination of PdNi electrocatalyst has gained the great attention. Due to the nano-structural architecture plays a crucial role in the catalytic activity, we synthesized novel Pd@Ni unsupported with carbon black catalyst in form of one-dimensional nickel nanospikes (Ni NSs) decorated by palladium nanoparticles. In this work, the impact of the changing in electronic structure of Pd@Ni catalysts on their catalytic properties was studied in detail (XANES, EXAFS, XPS, TEM, in situ FTiR). For small Pd crystals surrounded by a large dispersion of Ni substrate atoms, can refer to an increased metal-substrate interaction, which is associated with an increase in d-state vacancies in the Pd@Ni catalyst [1]. This may imply a greater susceptibility to chemisorption of unsaturated hydrocarbons (acetylene, ethylene), which may be electron donors. The higher number of d-state vacancies in material may indicate greater susceptibility to chemisorption of ethanol molecules, which further improves its catalytic activity. By using two different concentrations of Pd catalyst (0.5 mM and 0.75 mM), an attempt was made to determine the optimal electronic structure for the Pd@Ni system. By using synchrotron X-ray absorption spectroscopy, it was possible to determine the differences in the density of unoccupied Pd d-state in the produced materials, as well as changes in the local structure of the used support - 1D Ni nanospikes.

[1] Huang, D. *et al.* Effect of Ag-promotion on Pd catalysts by XANES. *Catalysis Letters*53, 155–159 (1998)

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

OPTICAL MICROSCOPE STATION FOR EXPERIMENT PREPARATION AT POLYX BEAMLINE

Krzysztof Olech,[1,*] Paweł Wróbel[1,2], Katarzyna M. Sowa[2] , Paweł Korecki[3], Tomasz Kołodziej[2], Filip J. Baran[2,4] and Błażej Ruszczycki[1]

[1]AGH University of Krakow, 30-059 Kraków, Poland
[2] NSRC SOLARIS, Jagiellonian University, 30-392 Krakow, Poland
[3]Institute of Physics, Jagiellonian University, 30-348 Krakow, Poland
[4]Doctoral School of Exact and Natural Sciences, Jagiellonian University, 30-348 Krakow, Poland
**E-mail: krolech@agh.edu.pl presenting author*

Micro-XRF experiments are often conducted on large amounts of heterogenous samples that have to be carefully inspected in order to find areas (Regions Of Interest - ROIs) or points desired for analysis. Typically, such an inspection is carried out at the beamline end-station with an optical microscope installed on it. This process of experiment preparation is however quite time-consuming – in case of experiments involving large amounts of samples or ROIs it may consume up to 25% of the total beamtime. Furthermore, due to space constraints the optical microscope installed at the beamline and its illumination system have limited capabilities and, in some cases make the experiment preparation a difficult task.

To overcome this problem at PolyX beamline a dedicated optical microscope station independent of the experimental end-station has been constructed. Equipped with a zoom microscope, high-resolution color camera and different sample illumination options (co-axial, ring-light and back-light) can be easily tuned to a given type of sample. It utilizes a 2 axis precision manipulator – on top of it a custom mounting system is installed enabling manual roll, pitch and yaw alignment of the 3D-printed tray with samples that can be easily moved between microscope station and beamline end-station. The whole station is covered with a light-sealed container. The software enables sample inspection and measurements, creation of mosaic images of large samples, changing microscope zoom and automated or manual focusing. Finally, it allows marking and management of ROIs (areas and/or points). The measurement procedure will be based on conversion of the ROIs coordinates defined in the microscope station manipulator frame to the experimental end-station manipulator frame. To facilitate this a set of reference points on the sample tray will be used.

During the presentation the discussion on challenges of the sample transfer and coordinates conversion will be given. The details on measurement work-flow and influence of simplifications on the accuracy of the coordinate conversion will be given. Furthermore, possible automation of the sample transfer process and tray alignment will be discussed as well.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

OXYGEN VACANCY FORMATION IN REDUCED ZRO2-X POWDERS AND 3D-PRINTED SCAFFOLDS: A SYNCHROTRON XPS/XAS STUDY

Amelia Rebejko[1,*], Klaudia Trembecka-Wójciga[1,2], Magdalena Jankowska[1], Joanna Ortyl[1,3,4]

[1]Department of Biotechnology and Physical Chemistry, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Warszawska 24, Cracow 30-155, Poland
[2]Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Reymonta 25, Cracow 30-059, Poland
[3]Photo HiTech sp. z.o.o, Bobrzyńskiego 14, Cracow 30-348, Poland
[4]Photo4Chem sp. z.o.o, Lea 114, Cracow 30-133, Poland
**E-mail: rebejko.amelia@gmail.com*

The proposed study aims to investigate the surface chemistry and electronic structure of oxygen-deficient zirconia, ZrO_{2-x}, obtained through thermal and magnesiothermic reduction. Particular attention will be paid to the transformation of stoichiometric ZrO_2 into reduced ZrO_{2-x}, associated with oxygen vacancy formation and possible Zr^{4+} to Zr^{3+} reduction. These processes are crucial for understanding interfacial bonding in Mg/ZrO_2 systems, especially in porous 3D-printed ceramic scaffolds [1]. Recent studies have shown that the interaction of ZrO_2 with molten magnesium under reducing conditions promotes oxygen redistribution, MgO formation, and the development of $Mg–ZrO_{2-x}$ interfacial bonds, despite the unfavorable macroscopic wetting behavior of this system [1]. In this experiment, pristine and reduced ZrO_2 powders and 3D-printed scaffolds will be studied using high-resolution X-ray photoelectron spectroscopy and X-ray absorption spectroscopy. XPS analysis of the Zr 3d and O 1s regions will identify changes in oxidation state and oxygen stoichiometry, while XAS measurements in TEY and TFY modes will compare surface and bulk effects.

The expected results will provide direct spectroscopic evidence of oxygen vacancy formation in reduced ZrO_{2-x} and help verify the role of oxygen management in Mg/ZrO_2 interfacial bonding.

Research funding from the National Center for Research and Development – LIDER PROJECT13/0081/2022 "Innovative porous ceramic materials printed by DLP technique using high-performance photochemical initiators dedicated to bone tissue integration"

[1] K. Trembecka-Wójciga et al., *Infiltration and reduction-driven interfacial bonding of molten magnesium in 3D-printed porous zirconia scaffolds*, **Materials & Design**, 2025, 260, 114944. DOI: 10.1016/j.matdes.2025.114944.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

HOW HYDROGENATION IMPACTS PROPERTIES OF RARE-EARTH-PALLADIUM-ALUMINIUM-BASED COMPOUNDS

Paulina Robótka,[1,*] Alexey Maximenko[2], Grzegorz Gazdowicz[2], Uladzislaw Gumiennik,[1] and Łukasz Gondek[1]

[1]*AGH University of Krakow, Faculty of Physics and Applied Computer Science, al. Mickiewicza 30, 30-059 Kraków, Poland*

[2]*National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Czerwone Maki 98, 30-392 Kraków, Poland*

**E-mail: probotka@agh.edu.pl*

Intermetallic compounds of rare-earth elements, palladium and aluminium have been known primarily for their unusual electronic and magnetic properties such as Kondo effect and heavy-fermion behavior. Although REPdAl (RE – rare-earth) compounds have been studied since the 1990s, their hydrogen storage capabilities had not been previously investigated. The main objective of this work was to determine the effect of hydrogen on the structure and local environment of selected atoms using advanced synchrotron studies.

The compounds were synthesized using arc melting in protective argon atmosphere and their hydrides were prepared using the Sieverts volumetric technique. It has been shown that compounds with light rare-earth elements (Ce-Sm) exhibit a high sorption capacity of up to ~2.4 H/f.u., whereas for heavier rare-earth elements (Gd-Tm) hydrogen concentration decreases to approximately 0.5 H/f.u.. The hydrogenation process leads to significant structural changes: the original hexagonal structure of the ZrNiAl type (P-62m) is not preserved for RE = Ce, Pr, Nd. Therefore, an orthorhombic structure (P222) was proposed to describe structure of those hydrides. Taking into account the lanthanides contraction, it seems that the above mentioned structure change could be related to some geometrical limits.

A pivotal component of the research was deployment of X-ray absorption spectroscopy (XAS). Analysis of X-ray absorption near edge structure (XANES) spectra showed that the oxidation state of rare-earth elements remains unchanged (+3) before and after hydrogenation, while extended X-ray absorption fine structure (EXAFS) indicated increase of a local disorder after hydrogen uptake. In contrast, distinct changes were observed in the fine structure of the absorption spectra for palladium, clearly indicating its crucial role in hydrogen bonding.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ENGINEERING MULTIFUNCTIONAL ELECTROSPUN CARBON NANOFIBER–IRON SULFIDE NANOARCHITECTURES FOR MAGNETICALLY TRIGGERED HYPERTHERMIA

Świątek M.[1]*, Lachowicz D.[1], Sokołowski K.[1], Jabłoński P.[1], Berent K.[1], Gajewska M.[1], Stępień J.[1], Gilarska A.[2], Kmita A.[1]

[1]AGH University of Krakow, Academic Centre for Materials and Nanotechnology, al. A. Mickiewicza 30, 30-059 Kraków, Poland

[2] AGH University of Krakow, Faculty of Physics and Applied Computer Science, al. A. Mickiewicza 30, 30-059 Kraków, Poland

E-mail: maswiatek@agh.edu.pl

Electrospun carbon nanofiber nanoarchitectures incorporating magnetic nanoparticles have emerged as promising materials for magnetically triggered hyperthermia due to their ability to generate localized heat under an alternating magnetic field. Electrospinning offers a versatile and scalable strategy for engineering porous nanofibrous architectures with tailored morphology, high specific surface area, and controlled nanoparticle distribution, making it an attractive platform for the development of multifunctional magnetic nanocomposites.

In this work, electrospun carbon nanofiber (CNF) composites incorporating iron sulfide nanoparticles (FexSy) were fabricated from polyacrylonitrile (PAN) solutions containing either iron acetylacetonate ($Fe(acac)_3$) and sulfur precursors or pre-synthesized FexSy nanoparticles, followed by stabilization and carbonization. SEM and TEM analyses confirmed the presence of continuous carbon nanofibers with uniformly distributed magnetic nanoparticles embedded within the carbon matrix. A particular focus was placed on synchrotron-based X-ray characterization, which enabled direct investigation of the nanoparticles inside the nanofibers. X-ray absorption spectroscopy (XAS), complemented by X-ray photoelectron spectroscopy (XPS), provided detailed information on the oxidation state, local atomic environment, and chemical bonding of iron species. These advanced techniques enabled precise identification of the phase composition and structural evolution of the encapsulated nanoparticles, which were inaccessible by conventional laboratory methods. Magnetic measurements using a vibrating sample magnetometer (VSM) confirmed the ferromagnetic behavior of the composites, demonstrating their potential for magnetic hyperthermia. The combination of electrospinning and advanced synchrotron characterization establishes a powerful approach for designing magnetic carbon nanofiber composites with optimized structure–property relationships for biomedical applications.

Acknowledgement:

This research was financed by the Polish Ministry of Science and Higher Education under subsidy No. 16.16.160.557 and partially supported by the AGH University of Krakow under the “Excellence Initiative – Research University” programme.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

SURFACE CHARACTERIZATION OF REDUCED ZrO_{2-x} IN 3D-PRINTED SCAFFOLDS AND POWDERS

Klaudia Trembecka-Wójciga,[1,*], Magdalena Jankowska[2], Weronika Wałczyk[2], Kamil Pulit and Joanna Ortyl

[1]*Institute of Metallurgy and Materials Science PAS, 30-059 Cracow, Poland*

[2]*Department of Biotechnology and Physical Chemistry, Faculty of Chemical Engineering and Technology, Cracow University of Technology, 30-155 Cracow, Poland*

**E-mail: k.trembecka@imim.pl*

This work investigates the chemical state and surface composition of zirconia (ZrO_2) reduced under magnesiothermic conditions, focusing on the transition from stoichiometric ZrO_2 to oxygen-deficient ZrO_{2-x}. Understanding these reduced forms is crucial for applications ranging from catalysis to advanced biomedical scaffolds.

In this study, both ZrO_2 powders and architected 3D-printed scaffolds were subjected to magnesiothermic reduction at 705 °C in an Ar/H_2 atmosphere in the presence of magnesium. A striking macroscopic color change from white to black was observed in both sample types, providing initial evidence of in-situ reduction (Fig.1). Synchrotron-based analyses conducted at the PHELIX beamline (SOLARIS National Synchrotron Radiation Centre) confirmed that the reduction process occurred and oxygen vacancies were successfully formed. High-resolution X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS) measurements allowed for the clear detection of the transition from Zr^{4+} to Zr^{3+} oxidation states. These results provide direct experimental validation of the "oxygen management" hypothesis, which suggests that oxygen transfer between the substrate, magnesium, and the atmosphere is the decisive factor for the successful infiltration of molten magnesium into ceramic scaffolds.

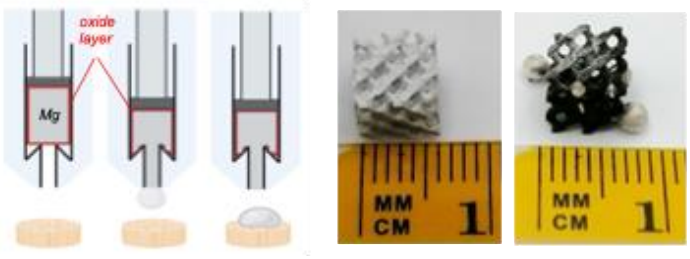


Figure 1. (a) High-temperature interaction and reduction of 3D-printed ZrO_2 scaffolds in contact with molten Mg (705 °C, Ar /H_2) (b) photographs of ZrO_2 scaffold before and after the experiment.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

UNVEILING CATALYST FUNCTIONALITY THROUGH IN SITU/OPERANDO X-RAY SPECTROSCOPY AT THE SOLARIS SYNCHROTRON

Anna Wach,[1,2,*] Michał Śliwa,[1] Agata Sabik[1], Marcin Brzeski[1], Marcin Zając[1], Zbigniew Sojka[3] and Jakub Szlachetko[1]

[1]*NSRC SOLARIS, Jagiellonian University, Krakow, Poland*

[2]*Institute of Physical Chemistry, Polish Academy of Sciences, Warszawa, Poland*

[3]*Faculty of Chemistry, Jagiellonian University, Kraków, Poland*

**E-mail: anna.wach@uj.edu.pl*

Catalysis plays a pivotal role in addressing global challenges in sustainable energy production, chemical manufacturing, and environmental protection, driving the development of advanced catalytic materials. Catalyst activity, selectivity, and stability are governed by structural and electronic changes occurring under reaction conditions, whereas conventional *ex situ* characterization provides only limited insight into catalyst functionality. *In situ* and operando X-ray spectroscopic techniques overcome these limitations by probing catalysts under working conditions, enabling the identification of active species, reaction intermediates, and dynamic structure-performance relationships at the molecular level.

This contribution presents the current capabilities and prospects of *in situ*/operando research at the SOLARIS synchrotron, highlighting the development of two complementary experimental platforms dedicated to catalysis research: the O-XAS (Operando X-ray Absorption Spectroscopy) and NAP-XPS (Near-Ambient Pressure X-ray Photoelectron Spectroscopy) end-stations. The O-XAS platform enables operando X-ray absorption spectroscopy under realistic reaction conditions, integrating online mass spectrometry (MS) and infrared spectroscopy (DRIFTS) for time-resolved monitoring of catalyst structure, reaction intermediates, and catalytic performance. The NAP-XPS platform enables surface-sensitive studies under near-ambient pressures by combining X-ray photoelectron spectroscopy with online MS, allowing simultaneous characterization of surface chemical states and catalytic activity in reactive gas environments. Together, these complementary platforms bridge bulk and surface characterization under operating conditions, providing a comprehensive framework for elucidating catalyst structure-activity relationships. The presentation will introduce their experimental capabilities and highlight the first operando studies performed at the SOLARIS synchrotron.

Acknowledgements: The work is supported by the Polish Ministry of Science and Higher Education, contract no.1/SOL/2021/2.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

EFFECT OF THERMAL REDUCTION AND MAGNESOREDUCTION ON THE SURFACE EVOLUTION OF 3D-PRINTED ZIRCONIA SCAFFOLDS

Weronika Walczyk,[1]* Magdalena Jankowska,[1,2] Klaudia Trembecka Wojciga[2,3] and Joanna Ortyl[2,4,5]

[1]*Cracow University of Technology, CUT Doctoral School, Faculty of Chemical Engineering and Technology, 31-155 Kraków, Poland*

[2]*Cracow University of Technology, Faculty of Chemical Engineering and Technology, 31-155 Kraków, Poland*

[3]*Institute of Metallurgy and Materials Science of the Polish Academy of Sciences, 30-059 Kraków, Poland*

[4] *Photo HiTech Ltd., 30–348 Kraków, Poland*

[5] *Photo4Chem Ltd., 30-133 Kraków, Poland*

**E-mail: weronika.walczyk@doktorant.pk.edu.pl*

Additively manufactured zirconia scaffolds offer unique opportunities for developing advanced materials with tailored architecture and surface properties. However, the influence of different reduction pathways on the surface chemistry and structural characteristics of 3D-printed zirconia is still not fully understood. This study investigates and compares the effects of thermal and magnesiothermic reduction on porous zirconia scaffolds.

As-fabricated, thermally reduced, and magnesiothermically reduced samples were examined using complementary microstructural, structural, and spectroscopic techniques, including X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS). Particular attention was given to changes in surface morphology, phase composition, chemical environment, oxygen stoichiometry, oxygen-vacancy formation, and zirconium chemical states resulting from oxygen loss during thermal treatment and magnesium-mediated oxygen transfer. The comparative analysis highlights similarities and differences between both reduction pathways and provides insight into their influence on the physicochemical properties of zirconia. The results contribute to a better understanding of reduction-driven surface transformations in additively manufactured zirconia and demonstrate the potential to tailor its surface chemistry through controlled processing. These findings may support the future development of oxygen-deficient zirconia scaffolds with properties optimized for advanced structural and biomedical applications.

Acknowledgement

This research work was financed by the LIDER NCBiR project, contract number LIDER13/0081/2022 and the OPUS NCN project, contract number 2021/41/B/ST5/04533.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

LOCAL STRUCTURE AND SITE PREFERENCE OF CO, NI AND CU DOPANTS IN CALCIUM ORTHOVANADATES

Anna Wolska,[1,*] Houri S. Rahimi Mosafer,[1] Christine Martin [2] Marek Berkowski,[1] Aleksandra Drzewiecka-Antonik,[1] Marcin Klepka[1]

[1]*Institute of Physics Polish Academy of Sciences, Al. Lotników 32/46 02-668 Warsaw, Poland*

[2]*Laboratoire CRISMAT, Normandie Université, ENSICAEN, UNICAEN, CNRS, 14050 Caen, France*

**E-mail: wolska@ifpan.edu.pl*

Calcium orthovanadate $Ca_3(VO_4)_2$ crystallizes in the R3c space group with a structure related to the mineral whitlockite. Its structural versatility enables partial substitution of Ca cations by ions with valence states ranging from +1 to +4 without changing the global symmetry of the host lattice. Such substitution provides a route to tuning optical, electronic and magnetic properties, making these materials promising for optoelectronic applications. The Ca cations occupy five inequivalent crystallographic positions (M1–M5) with different coordination geometries; therefore, identifying the preferred dopant site is essential for understanding the relationship between local atomic-scale modifications and macroscopic functional behavior.

Here, we investigate crystals of $Ca_{10.5-x}TM_x(VO_4)_7$, where TM = Co, Ni or Cu and nominal x = 0.50 or 0.66. X-ray absorption fine structure (XAFS) measurements were performed at the ASTRA beamline of the SOLARIS National Synchrotron Radiation Centre in fluorescence mode. The experimental XANES and EXAFS data were complemented by theoretical simulations for structural models in which the dopant occupies each of the five inequivalent Ca sites.

The XAFS analysis shows that the experimental spectral features are most consistent with substitution at a single crystallographic position. Comparison of the experimental data with theoretical XANES simulations, together with the EXAFS analysis, reveals a strong preference of Co, Ni and Cu dopants for the M5 site, characterized by sixfold oxygen coordination. The results demonstrate site-selective incorporation of the transition-metal ions and provide local-structure information relevant to the rational tailoring of TM-doped calcium orthovanadates for potential optoelectronic applications.

Acknowledgements: The authors acknowledge the SOLARIS Centre for access to the ASTRA beamline. The access was financed by the Polish Ministry of Education and Science, decision no. 1/SOL/2021/2.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

MAVKA – X-RAY MICROSPECTROSCOPY BEAMLINE AT SOLARIS SYNCHROTRON

Artem Yakovliev[1,2], Danylo Babich[3], Anna Wach[1], Marcin Zając[1], Michał Młynarczyk[1], Marcin Sikora[1], Adriana Wawrzyniak[1], Jarosław Wiechecki[1], Andrzej Marendziak[1], Paweł Bulira[1], Paweł Nowak[1], Leonid Rivkin[3], Rolf Follath[4], Marco Calvi[4], David Marco Just[4], Daniel Grolimund[4], Marcel Brüstle[4], Alexander Kordyuk[5], Volodymyr Bezguba[5], Volodymyr Karbivskyy[6], Ihor Sukhenko[6], Andrei Hloskovsky[7], Oksana Chukova[7], Martin Sandhop[7], Wolfgang Drube[7], Jakub Szlachetko[1], Luc Patthey[4]

[1]SOLARIS National Synchrotron Radiation Centre, 30-392 Krakow, Poland

[2]Institute of Nuclear Physics, Polish Academy of Sciences, Kraków 31-342, Poland

[3]Swiss Light Source, Paul Scherrer Institut, 5232 Villigen, Switzerland

[4]PSI Center for Photon Science, Paul Scherrer Institute, 5232 Villigen, Switzerland

[5]Kyiv Academic University, 03142 Kyiv, Ukraine

[6]G. V. Kurdyumov Institute for Metal Physics, 03142 Kyiv, Ukraine

[7]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany

**E-mail: artem.yakovliev@uj.edu.pl*

MAVKA beamline is undergoing construction at the SOLARIS synchrotron within the "Light for Ukraine" project, initiated by the League of European Accelerator-based Photon Sources (LEAPS). The project aims to support and expand opportunities for the Ukrainian scientific community by providing them with an easier access to the synchrotron research.

The source of the X-ray radiation for MAVKA beamline is an in-vacuum undulator, which will be able to generate high brilliance radiation in a wide 0.5 – 12 keV energy range. Combination of plane grating monochromator (PGM) and double crystal monochromator (DCM) within the single optical branch will enable operation in soft and hard X-ray energy ranges respectively. The focusing of the beam will be handled by a combination of the bendable toroidal mirror and dedicated Kirkpatrick–Baez (KB) mirror systems. The beam spot size on the sample is expected to be from ~50 μm to ~1 μm depending on the endstation.

Currently, MAVKA beamline project envisions construction of the two endstations: X-ray photoelectron spectroscopy (XPS) endstation and ambient pressure hard X-ray photoelectron spectroscopy (AP-HAXPES) endstation. These endstations will provide users with a comprehensive set of research tools for studies in energy storage, alternative energy sources, nanoelectronics, electrochemistry and catalysis. Additionally, construction of the third endstation for high resolution X-ray spectroscopy/diffraction studies is under consideration.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

IRON-MODIFIED STRONTIUM TITANATE FOR CATALYTIC POLYPROPYLENE PYROLYSIS TOWARD HYDROGEN GENERATION

Jakub Zdankiewicz,[1]* Michał Dominów,[1] Jakub Karczewski,[1] Piotr Jasiński,[2] Beata Bochentyn[1]

[1] Faculty of Applied Physics and Mathematics, Gdansk University of Technology 80-233 Gdańsk, ul. Narutowicza 11/12 Poland

[2] Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology, 80-233 Gdańsk, ul. Narutowicza 11/12 Poland

* *jakub.zdankiewicz@pg.edu.pl*

Plastic pyrolysis is the thermal decomposition of plastics under oxygen-free conditions at high temperatures, producing pyrolytic gas, liquid oils, and solid carbon. The gas consists mainly of hydrogen and hydrocarbons, and its composition can be controlled by reaction conditions and catalyst selection.[1] Iron-based metal-supported catalysts increase hydrogen production. Conventional metal-support catalysts suffer from limited lifetime due to metal instability and carbon deposition.[2] Exsolution of metallic nanoparticles is a promising strategy for preparing more stable catalysts. High-temperature reduction of B-site-doped perovskites causes dopant metals to exsolve as nanoparticles that are strongly anchored to the oxide support, improving thermal stability and resistance to carbon deposition.[3]

In this work, three catalysts were prepared: strontium titanate mixed with iron(III) oxide; strontium titanate iron-impregnated by nitrate solution; and iron-doped strontium titanate with the general formula $Sr_{0.95}Ti_{0.8}Ni_{0.2}O_{3-x}$. Materials were synthesized using Pechini method, reduced in H_2 at 900°C, evaluated as pyrolysis catalyst and regenerated by sintering in CO_2 atmosphere. Catalysts before pyrolysis, after pyrolysis, and after regeneration were characterized by XPS and XAS at the PHELIX beamline of the SOLARIS National Synchrotron Radiation Centre.

Acknowledgements

This work was supported by the National Science Center under grant No. 2021/42/E/ST5/00450 and by the National Centre for Research and Development of Poland and Ministry of Science and Technology of Taiwan by the 10th Polish-Taiwanese/Taiwanese-Polish Joint Research Project DWM/POLTAJ10/24/2023.

References

1. R. Mishra et al. *ACS Sustainable Chemistry & Engineering*, 11(6) (2023) 2033–2049
2. J. C. Acomb, C. et al. *Applied Catalysis B: Environmental* 180 (2016) 497–510
3. A. J. Carrillo et al. *Chem. Commun*. 60 (2024) 7987-8007

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

FROM NANODOTS TO NANOCAGES: OPERANDO INSIGHTS INTO AU–Cu_2O ETHANOL ELECTROCATALYSIS

Babak Alavi,[1,*] Joanna Depciuch,[1] Mohammad Sadegh Shakeri,[1] Kamil Sobczak,[2] Lulu Alluhaibi,[3] Krzysztof Matlak,[3] and Magdalena Parlinska[1]

[1]*Institute of Nuclear Physics, Polish Academy of Sciences, 31-342 Kraków, Poland*

[2]*Faculty of Chemistry, Biological and Chemical Research Centre, University of Warsaw, Poland*

[3]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*

**Presenting author. E-mail: babak.alavi@ifj.edu.pl*

Cu_2O nanocubes decorated with gold via a galvanic replacement reaction (GRR) yield three distinct nanoarchitectures such as Au-decorated, Au@Cu_2O core-shell, and hollow Au nanocages, with strongly morphology-dependent activity toward the ethanol oxidation reaction (EOR). We correlate this activity with the structural and chemical evolution captured at the SOLARIS National Synchrotron Radiation Centre. Scanning transmission X-ray microscopy (STXM) at the DEMETER beamline maps the redistribution of Cu_2O and residual CuO as the GRR proceeds from decorated to hollow morphologies, while operando Raman spectroscopy at the ASTRA beamline follows the vibrational response of each architecture under EOR conditions.

The Au-decorated catalyst shows the strongest, most dynamic Raman signal, the highest electrochemically active surface area (486 cm^2/mgAu), and the best cycling stability (98% ECSA retention after 1000 cycles), while *in-situ* IRRAS confirms it drives ethanol fully to CO_2; the hollow architecture instead stalls at acetaldehyde and deactivates rapidly. These correlative operando results identify accessible Au-Cu_2O interfacial area, rather than total surface area, as the key parameter governing selective and durable ethanol electrooxidation, highlighting the power of SOLARIS multimodal operando capabilities for catalyst design.

Acknowledgments: This research was funded by the National Science Centre, Poland (UMO-2023/49/B/ST11/01504) and partially developed under Ministry of Science and Higher Education contract 1/SOL/2021/2 supporting research infrastructure of the SOLARIS National Synchrotron Radiation Centre. The authors acknowledge SOLARIS Centre for access to the DEMETER (STXM) and ASTRA (operando Raman) beamlines.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

STUDY OF ELECTRONIC STRUCTURE IN $Co_{0.5}Zn_{0.5}Fe_2O_4$@GO WITH POTENTIAL APPLICATION IN HYPERTHERMIA

A.Bajorek[1,*], Ch. Ch. Dey[2], M. K. Mondal[2], S.Das[2], N. Bhakta[2], S.Sadhukhan[2], Raghumani S.Ningthoujam[3], T. Sobol[4] and P. K. Chakrabarti[2]

[1]*A. Chełkowski Institute of Physics, University of Silesia in Katowice, Poland*
[2]*Solid State Research Laboratory, Department of Physics, Burdwan University, India*
[3]*Chemistry Division, Bhabha Atomic Research Centre, Mumbai, India.*
[4]*National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Kraków, Poland.*
[5]*Sidho Kanho Birsha University, Purulia, West Bengal, India.*

**E-mail: anna.bajorek@us.edu.pl/presenting author*

To overcome the limitations of monotherapy for cancer treatment, magnetic nanoparticles (MNPs) in combination with the multifunctional graphene oxide (GO) and additionally polyethylene glycol (PEG) polymer were discussed. The crystal structure and formation of Co0.5Zn0.4Cu0.1Fe2O4@GO@PEG (CZCFGP) were evidenced by XRD. The counterpart CZCFG and GO samples were analyzed by XPS and, additionally, by XAS using the PHELIX beamline at Solaris synchrotron. The synergy between CZCF-GO was confirmed. The XAS data were also compared with those of the FZ@MWCNTs-GO composite. Heat generation due to rapid magnetic-field fluctuations (200 kHz) was compared among pristine CZCF, CZCFG and CZCFGP. Interestingly, the presence of both GO and PEG matrices enhances heat generation compared to CZCF and CZCFG. As found, the agglomeration of NPs reduces magnetic induction heating, and CZCFGP exhibits the highest SAR value (86.9 W/g) at 1 mg/mL and 200 kHz, thereby making it a potential candidate for hyperthermia therapy.

Acknowledgements

The authors wish to acknowledge WB DST (Memo no. 292 (sanc.)/ST/P/S&T/16G-28/2017 dt. 28/03/2018). The authors are also grateful for partial support from the Polish Ministry and the Higher Education project Support for research and development with the use of research infrastructure of the "National Synchrotron Radiation Centre SOLARIS "under contract nr 1/SOL/2021/2. We also acknowledge SOLARIS Centre for the access to the PHELIX Beamline, where measurements were performed under the granted SOLARIS/PHELIX/212044 proposal.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

INSIGHTS INTO SPIN-CROSSOVER IN FE(II)–TRIAZOLE NANOPARTICLES FROM X-RAY ABSORPTION AND MÖSSBAUER SPECTROSCOPIES

Aleksandra Pacanowska[1], Kamila Komędera[2], Naveen Kumar Chogondahalli Muniraju[1], Damian Rybicki[2], Alexey Maximenko[3], Wojciech Tabiś[2], and Magdalena Fitta[1*],

[1]Institute of Nuclear Physics Polish Academy of Sciences, 31-342 Kraków, Poland

[2]AGH University of Kraków, 30-059 Kraków, Poland

[3]National Synchrotron SOLARIS Radiation Centre, Jagiellonian University,30-392 Kraków, Poland

**E-mail: Magdalena.Fitta@ifj.edu.pl*

Spin-crossover (SCO) Fe(II)-based coordination compounds undergo reversible switching between high-spin (HS) and low-spin (LS) states in response to external stimuli such as temperature, pressure, or light. The accompanying changes in electronic, structural, magnetic, and optical properties make these materials attractive for molecular electronics, sensing, and information storage.

In this work, we investigate the spin-crossover behavior of microcrystalline and nanocrystalline $[Fe(Htrz)_2(trz)](BF_4)@SiO_2$ (Htrz: 1,2,4-1H-triazole) coordination polymers using temperature-dependent Mössbauer spectroscopy and Fe K-edge X-ray absorption spectroscopy (XAS). The complementary application of XANES, EXAFS, and Mössbauer spectroscopy provide detailed insight into the correlation between electronic configuration and local structural evolution during the spin transition. While Fe(II)–triazole nanoparticles (~40 nm) preserve reversible HS↔LS switching, they exhibit reduced cooperativity and lower transition temperatures compared with the microcrystalline material. XAS reveals an expansion of the Fe–N bond distance from 1.96 Å to 2.15 Å accompanied by increased local structural disorder, whereas Mössbauer spectroscopy identifies the redistribution of spin populations across the hysteretic transition and a residual surface-stabilized HS fraction. These findings demonstrate the strong influence of particle size on the spin-transition mechanism and highlight the value of combining X-ray absorption and Mössbauer spectroscopies for elucidating structure–property relationships in SCO nanomaterials.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

ROLE OF THE Fe^{2+}/Fe^{3+} RATIO IN THE CO-PRECIPITATION SYNTHESIS AND PROPERTIES OF IRON OXIDE NANOPARTICLES

Uladzislaw Gumiennik[1,*], Paulina Robótka[1], Czesław Kapusta[1], and Janusz Przewoźnik[1]
[1]*AGH University of Krakow, 30-059 Kraków, Poland*
**E-mail: gumienni@agh.edu.pl*

The structural and magnetic properties of magnetite (Fe_3O_4) nanoparticles strongly depend on the synthesis conditions, making precise control of the preparation parameters essential for tailoring their performance in technological and biomedical applications. This work investigates the influence of the Fe^{2+}/Fe^{3+} precursor ratio on the structure, microstructure, and magnetic properties of $Fe_{3-\delta}O_4$ nanoparticles synthesised by co-precipitation.

The synthesised $Fe_{3-\delta}O_4$ nanoparticles were characterised by X-ray diffraction (XRD) with Rietveld refinement. The Fe oxidation state and local environment of the iron atoms were investigated by X-ray absorption spectroscopy (XAS) and Mössbauer spectroscopy. Their magnetic properties were examined by vibrating-sample magnetometry (VSM) in the temperature range of 3–300 K and in magnetic fields up to 9 T.

XRD analysis confirmed the formation of single-phase magnetite-like $Fe_{3-\delta}O_4$ structure (space group *Fd*-3*m*, No. 227) in all samples. The Fe^{2+}/Fe^{3+} precursor ratio strongly influenced the Fe^{2+} vacancy concentration (δ), nanoparticle size, and lattice parameter. Increasing Fe^{2+}/Fe^{3+} precursor ratio increased the nanoparticle size from 5.5 to 35.1 nm and lattice parameter from 8.371 to 8.393 Å. X-ray absorption near-edge structure (XANES) analysis corroborated the Mössbauer results, revealing a gradual shift in the Fe oxidation state towards that of stoichiometric maghemite (γ-Fe_2O_3) with decreasing Fe^{2+}/Fe^{3+} precursor ratio. Extended X-ray absorption fine structure (EXAFS) analysis revealed a clear correlation between decreasing nanoparticle size and increasing local structural disorder. The observed increase in saturation magnetization with increasing nanoparticle size and reduced structural disorder suggests improved magnetic ordering in larger and less defective nanoparticles.

This work was supported by the European Union under grant agreement no. NDICI-GEONEAR/2023/444-419-0008. Research at the National Synchrotron Radiation Centre SOLARIS is supported by the Ministry of Science and Higher Education, Poland, under contract no. 1/SOL/2021/2. We would like to thank Katarzyna Sowa and Krzysztof Pitala for support and assistance during the experiments at SOLARIS.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

INTERFACIAL EXCHANGE COUPLING IN NiO/Fe_3O_4(001) ACROSS THE VERWEY TRANSITION VISUALIZED BY XMCD AND XMLD-PEEM

Anna Mandziak,[1,*] Jose Emilio Prieto,[2] Miguel Agnel Nino,[2] Clara Gutierrez-Cuesta,[2] Juan de la Figuera,[2] Mateusz Pączek,[3] Mikołaj Domasik,[3] Paweł Nita,[3]

[1]*National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Kraków,Poland*

[2]*Instituto Quimica Fisica Blas Cabrera, CSIC, Madrid, Spain*

[3]*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, Kraków,Poland*

**E-mail: anna.mandziak@uj.edu.pl*

The Verwey transition in Fe_3O_4 provides a natural way to modify the magnetic state of an exchange-coupled NiO/Fe_3O_4(001) heterostructure without changing its chemical composition or interface structure. The transition involves a lowering of the crystal symmetry together with changes in magnetic anisotropy and the resulting domain configuration. Here, we use XMCD- and XMLD-PEEM to examine how these changes affect the relationship between ferrimagnetic domains in Fe_3O_4 and antiferromagnetic domains in epitaxial NiO films.

Previous studies of NiO/Fe_3O_4(001) reported that the NiO spin axis lies predominantly in the sample plane along the Fe_3O_4 ⟨100⟩ directions, leading mainly to collinear coupling between the two magnetic layers [1,2]. We compare the Fe_3O_4 XMCD and NiO XMLD domain patterns at room temperature and below the Verwey transition. Cooling through the transition produces a pronounced reorganization of the Fe_3O_4 magnetic domain structure. At the same time, the NiO XMLD contrast changes accordingly and remains spatially correlated with the underlying ferrimagnetic domains.

These observations show that the antiferromagnetic configuration of NiO responds to the transition-induced rearrangement of the Fe_3O_4 domain pattern. To our knowledge, this is the first direct PEEM observation of such a reconfiguration in NiO/Fe_3O_4(001) across the Verwey transition. The results demonstrate that the interfacial exchange coupling remains effective despite the structural and magnetic changes occurring in magnetite.

[1] M. Pilard et al., Phys. Rev. B, 76, 214436 (2007).
[2] C. Boeglin et al., Phys. Rev. B, 80, 035409 (2009).

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

EXPLORING SPIN TEXTURES IN WSe_2 AND AU(111) BY SPIN-RESOLVED ARPES

Natalia Olszowska,[1,*] Dawid Wutke,[1] Rafał Kurleto,[1] and Jacek J Kołodziej[2]

[1]*National Synchrotron Radiation Centre SOLARIS, Jagiellonian University, Czerwone Maki 98, 30-392 Kraków, Poland*

[2]*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, prof. Stanisława Łojasiewicza 11, 30-348 Kraków, Poland*

**E-mail: natalia.olszowska@uj.edu.pl*

Spin-resolved angle-resolved photoemission spectroscopy (SARPES) provides direct access to the spin texture of electronic states and is a key technique for investigating materials with strong spin–orbit coupling. Reliable spin-resolved measurements require well-characterized reference systems with robust and reproducible spin polarization. Transition metal dichalcogenides and Rashba systems are among the most important benchmark materials, representing two distinct classes of spin-polarized electronic structures arising from strong spin–orbit interaction and broken inversion symmetry.

Here, we investigate monolayer WSe_2 and the Au(111) surface as archetypal representatives of these material classes. Monolayer WSe_2 exhibits spin–valley locking, whereas Au(111) hosts the prototypical Rashba-split Shockley surface state. Their well-established electronic structures and characteristic spin textures make them ideal reference systems for evaluating SARPES performance.

Using SARPES, available at the URANOS beamline, we directly probe the spin polarization of both materials while calibrating and characterizing the double VLEED spin detector. The excellent agreement with the expected spin characteristics demonstrates the reliability of the measurements and confirms the performance of the spin detector. In addition, we present its key performance parameters, including the energy, angular, and spin resolution, as well as the Sherman function and figure of merit (FOM).

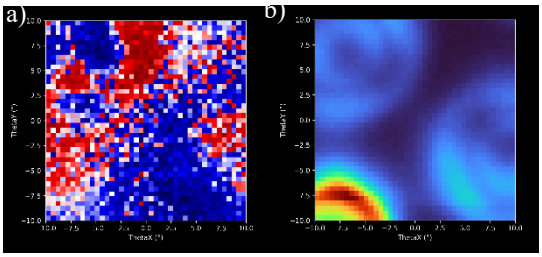


Fig. 1. (a) Spin-resolved k_x–k_y map of the out-of-plane spin polarization component, S_z, of monolayer WSe_2, measured at a photon energy of 50 eV using horizontally polarized light. The map was acquired at a constant energy of 0.8 eV below the Fermi level. (b) Sum of the $S_z^{+¿¿}$ and $S_z^{-¿¿}$ spin-resolved intensities.

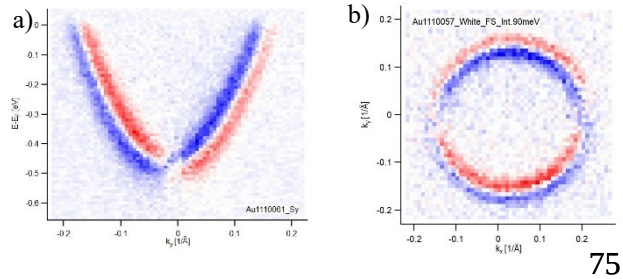


Fig. 2. S_y spin polarization of the Rashba-split surface state of Au(111), measured as (a) a k_y spectrum and (b) a constant-energy k_x–k_y map acquired at 0.1 eV below the Fermi level.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

NANOSCALE CHARACTERIZATION OF 3D-PRINTED CARBON DOT-BASED HYDROGELS USING SEM, AFM, NANO-FTIR AND S-SNOM

Joanna Ortyl,[1,2,3,*] Kasidid Yaemsunthorn,[1] and Agnieszka Sysło[4]

[1]Politechnika Krakowska im. Tadeusza Kościuszki, Wydział Inżynierii i Technologii Chemicznej, Katedra Biotechnologii i Chemii Fizycznej, ul. Warszawska 24, 31-155

[2]Photo HiTech sp z.o.o, Bobrzyńskiego 14, 30-348 Kraków, Polska

[3]Photo4Chem sp. z.o.o, Lea 114, 30-133 Kraków, Polska

[4]Politechnika Krakowska im. Tadeusza Kościuszki, Szkoła Doktorska PK, Wydział Inżynierii i Technologii Chemicznej, ul. Warszawska 24, 31-155

**E-mail: joanna.ortyl@pk.edu.pl*

Three-dimensional (3D) printing has become an important manufacturing technology for producing complex, patient-specific structures with high precision while minimizing material consumption. Among various printable materials, carbon dot (CD)-based hydrogels have attracted growing attention owing to the unique optical properties, biocompatibility, and tunable surface chemistry of carbon dots, making them promising candidates for biomedical and tissue engineering applications. Despite their increasing use, limited information is available regarding the distribution of carbon dots within polymeric matrices and the influence of their morphology on the resulting material properties.

In this work, citric acid-derived carbon dots were incorporated into photocurable hydrogels and processed by photopolymerization to fabricate three-dimensional structures. The printed materials were characterized using scanning electron microscopy (SEM), atomic force microscopy (AFM), nano-Fourier transform infrared spectroscopy (nano-FTIR), and scattering-type scanning near-field optical microscopy (s-SNOM). These complementary techniques enabled the evaluation of surface morphology, chemical heterogeneity, and the spatial distribution of carbon dots within the polymer matrix. The results provide valuable insights into the structure of carbon dot-based hydrogels, supporting the development of advanced photoactive materials for photopolymerization, 3D printing, and biomedical applications.

This research was funded by the NCN project OPUS (“Emerging strategy approaches for the design and functionalization of carbon dots as multifunctional, dynamic, green systems photoinitiators and photocatalysts involved in photopolymerisation processes”), Grant No. UMO-2021/41/B/ST5/0453

P35

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

AMBIPOLAR SEEBECK COEFFICIENT IN $MoS_2/MoS_2–MoO_2$ GRADED COMPOSITES BY JUNCTION RECIPROCATION

Abinaya Rengarajan,[1,*] Archana Jayaram,[2] Navaneethan Mani[3] and Krzysztof T. Wojciechowski[1*]

[1]*Thermoelectric Research Laboratory, Department of Inorganic Chemistry, Faculty of materials Science and Ceramics, AGH University of Kraków, 30-059 Kraków, Poland*

[2]*Center of Excellence in Materials and Advanced Technologies (CeMAT), SRM Institute of Science and Technology, Kattankulathur 603203, India*

[3]*Nanotechnology Research Centre, SRM Institute of Science and Technology, Chengalpattu - 603203, Tamil Nadu, India*

**E-mail: abinaya@agh.edu.pl*

We report a radially graded MoS_2-to-$MoS_2–MoO_2$ thin film fabricated via a two-zone chemical vapor transport process, where excess MoO_3 vapor induces a continuous compositional gradient from pristine MoS_2 at the edge to an oxygen-rich $MoS_2–MoO_2$ region at the center. Electron-probe microanalysis, Raman spectroscopy, and X-ray photoelectron spectroscopy confirm the coexistence of MoS_2 and MoO_2 across six distinct regions. Reversing the thermal gradient reveals an ambipolar Seebeck response: heating the MoS_2 side produces a small negative coefficient, while heating the $MoS_2–MoO_2$ side yields a larger positive value. This behavior is attributed to enhanced hole injections, reduced Fermi-level pinning, and carrier filtering across multiple interfacial barriers. Time-resolved measurements show faster voltage saturation when the oxidized region is heated, while cyclic tests reveal reproducible hysteresis linked to interfacial barriers. Raman analysis indicates lattice softening toward the oxidized region, supporting combined effects of carrier filtering and phonon scattering. These results highlight potential-barrier engineering at TMD–oxide interfaces as an effective strategy to tune thermoelectric performance, motivating future synchrotron X-ray absorption studies at the SOLARIS PIRX beamline.

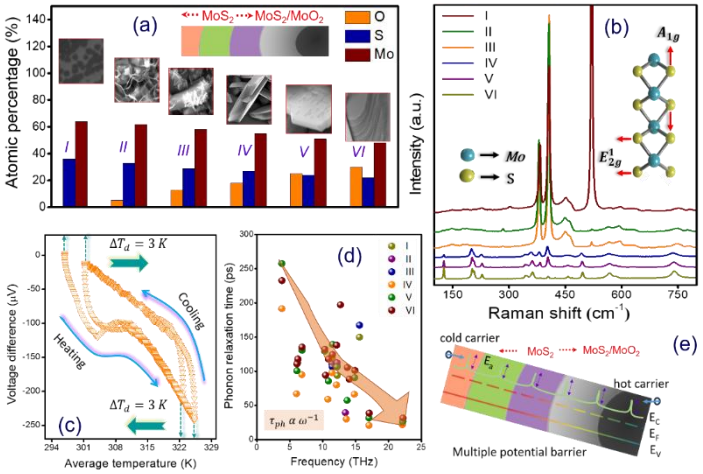


Figure. (a) FESEM composition analysis on gradient film, (b) Raman spectra at each region, (c) Hysteresis of Seebeck coefficient, (d) Phonon relaxation time vs frequency estimated from Raman data, (d) Schematic illustration of multiple potential barriers on graded composites[1]

References.

1. Abinaya et.al., J. Phys. Chem. Lett. 49, 12060–12067 (2024)
2. Buscema, M. et al., *Nano Lett.* 13, 358–363 (2013)

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

EXPLORING CARBON DOT SURFACE CHEMISTRY BY SYNCHROTRON FTIR MICROSCOPY

Dawid Skwarczek[1,*], Agnieszka Sysło[1,2], Patryk Szymaszek[1], Joanna Ortyl[1,3,4]
[1]Politechnika Krakowska im. Tadeusza Kościuszki, Wydział Inżynierii i Technologii Chemicznej, Katedra Biotechnologii i Chemii Fizycznej, ul. Warszawska 24, 31-155
[2]Politechnika Krakowska im. Tadeusza Kościuszki, Szkoła Doktorska, Wydział Inżynierii i Technologii Chemicznej, ul. Warszawska 24, 31-155
[3]Photo HiTech sp z.o.o, Bobrzyńskiego 14, 30-348 Kraków, Polska
[4]Photo4Chem sp. z.o.o, Lea 114, 30-133 Kraków, Polska
**E-mail: dawid.skwarczek@student.pk.edu.pl*

Carbon dots (CDs) are a class of fluorescent carbon-based nanomaterials that have attracted considerable attention due to their excellent water dispersibility, chemical stability, low toxicity, and tunable optical properties. These characteristics make them promising candidates for applications in photocatalysis, sensing, bioimaging, and photochemical processes. Despite extensive research, the relationship between the chemical structure of carbon dots and their optical performance remains insufficiently understood. In this work, carbon dots synthesized by a facile and cost-effective approach were comprehensively characterized to investigate the correlation between their chemical composition and photophysical properties.

The obtained materials were analyzed using UV-Vis absorption, fluorescence spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, and liquid chromatography-mass spectrometry (LC–MS). In addition, synchrotron-based FTIR microscopy measurements were performed at the CIRI (Chemical InfraRed Imaging) beamline at the SOLARIS National Synchrotron Radiation Centre. The CIRI FTIR microscope enables high-spatial-resolution chemical imaging and infrared mapping, allowing the distribution of surface functional groups and chemical heterogeneity within the carbon dot samples to be investigated with micrometre-scale resolution. The combined application of spectroscopic and microscopic techniques provides complementary information on the surface chemistry and structural organization of carbon dots. These findings contribute to a better understanding of the relationship between chemical composition and the optical properties of carbon-based nanomaterials.

This research was funded by the National Science Centre (NCN, Poland), OPUS, ("Emerging strategy approaches for the design and functionalization of carbon dots as multifunctional, Dynamics, green systems photoinitiators and photocatalysts involved in photopolymerisation processes") Grant No. UMO-2021/41/B/ST5/0453

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

ADVANCED SYNCHROTRON CHARACTERIZATION OF METAL-DOPED CARBON DOTS USING PHELIX AND DEMETER BEAMLINES

Agnieszka Sysło,[1,2,*] Kasidid Yaemsunthorn,[1] Wiktor Kasprzyk,[1] and Joanna Ortyl[1,3,4]

[1]Politechnika Krakowska im. Tadeusza Kościuszki, Wydział Inżynierii i Technologii Chemicznej, Katedra Biotechnologii i Chemii Fizycznej, ul. Warszawska 24, 31-155

[2]Politechnika Krakowska im. Tadeusza Kościuszki, Szkoła Doktorska PK, Wydział Inżynierii i Technologii Chemicznej, ul. Warszawska 24, 31-155

[3]Photo HiTech sp z.o.o, Bobrzyńskiego 14, 30-348 Kraków, Polska

[4]Photo4Chem sp. z.o.o, Lea 114, 30-133 Kraków, Polska

**E-mail: agnieszka.syslo@doktorant.pk.edu.pl*

Metal-doped carbon dots (CDs) have attracted considerable attention owing to their tunable optical, electronic, and catalytic properties, making them promising candidates for photocatalysis, sensing, bioimaging, and optoelectronic applications. Nevertheless, the influence of metal dopants on the electronic structure, chemical composition, and local heterogeneity of carbon dots remains insufficiently understood. In this work, metal-doped carbon dots were comprehensively investigated using synchrotron-based techniques available at the PHELIX and DEMETER beamlines of the SOLARIS National Synchrotron Radiation Centre. X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS) performed at PHELIX provide detailed information on elemental composition, oxidation states, electronic structure, and the local chemical environment of carbon, oxygen, and metal dopants. Complementary scanning transmission X-ray microscopy (STXM) combined with XAS at DEMETER enables high-resolution chemical imaging, revealing the spatial distribution of dopants and chemical heterogeneity within the carbon dot agglomerates. The combination of these techniques provides comprehensive insight into the structure–property relationships of metal-doped carbon dots, supporting the rational design of advanced photoactive nanomaterials for photocatalytic and photochemical applications.

This research was funded by the NCN project OPUS (“Emerging strategy approaches for the design and functionalization of carbon dots as multifunctional, dynamic, green systems photoinitiators and photocatalysts involved in photopolymerisation processes”), Grant No. UMO-2021/41/B/ST5/0453

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

LOW-ANGLE X-RAY PHOTOELECTRON SPECTROSCOPY AND X-RAY REFLECTOMETRY FOR METALLIC NANOLAYER CHARACTERIZATION

G. Wesołowski [1,*], A. Kubala-Kukuś[1,2], D. Banaś[1,2], K. Szary[1,2], I. Stabrawa[1,2], P. Jagodziński[1,3], R. Stachura[1,3], D. Sobota[1] M. Borysiewicz[4], O. Sadowski[4], J. Chojenka[5], I. Carlomagno[6], J. R. Herrera[6]

[1]*Institute of Physics, Jan Kochanowski University, 25-406 Kielce, Poland*

[2]*Holy Cross Cancer Center, 25-734 Kielce, Poland*

[3]*Central Office of Measures, 00-139 Warszawa, Poland*

[4]*Łukasiewicz - Institute of Microelectronics and Photonics, 02-668 Warszawa, Poland*

[5]*Institute of Nuclear Physics Polish Academy of Sciences, 31-342 Kraków, Poland*

[6]*Elettra-Sincrotrone Trieste, 34-149 Trieste, Italy*

**E-mail:* grzegorz.wesolowski@ujk.edu.pl

Low-angle X-ray Photoelectron Spectroscopy (XPS) and X-ray Reflectometry (XRR) are powerful tools for non-destructive characterization of thin films [1, 2].

In this work, we present a comprehensive, synergistic approach combining Total Reflection XPS (TRXPS) [3], Grazing Incidence XPS (GIXPS), and synchrotron-based XRR to evaluate the structural and chemical properties of gold (Au) nanolayers (1–100 nm) on silicon [4]. Standard XPS measurements yielded elemental composition, chemical states, and film homogeneity. In the study, detection limits in the TRXPS regime at various glancing angles, as well as experimental GIXPS angular scans, were obtained. Complementary synchrotron XRR measurements at Elettra Sincrotrone Trieste precisely determined the thickness and density of the layers and substrate, as well as the roughness of all interfaces. This methodology provides a solid foundation for our ongoing research on structural and chemical changes induced in metallic nanolayers by highly charged ions.

Acknowledgements: This work was co-financed by the Polish Minister of Science under the "Regional Excellence Initiative" (RID/SP/0015/2024/01).

References:

[1] M. J. Chester, T. Jach, *Phys. Rev. B* 48 (1993) 17262.

[2] J. Daillant, A. Gibaud (eds.), X-Ray and Neutron Reflectivity: Principles and Applications, *Springer* (2009).

[3] A. Kubala-Kukuś, D. Banaś et al., *Spectrochim. Acta Part B* 145 (2018) 43-50.

[4] G. Wesołowski, A. Kubala-Kukuś et al., *X-Ray Spectrometry* 55 (2026) 163-175.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

PHELIX END STATION - A RESEARCHER'S PLAYGROUND

Barbara Wolanin,[1,*] Tomasz Sobol,[1] Edyta Beyer,[1] Agata Sabik,[1] Anna Wach[1]
[1]*NSRC SOLARIS, Jagiellonian University, 31-007 Krakow, Poland*
**E-mail: barbara.wolanin@uj.edu.pl*

The PHELIX research end station is an advanced, multi-chamber system installed at the synchrotron SOLARIS [1]. The infrastructure is designed to study solid samples, powders, and interfaces using various spectroscopy methods under ultrahigh vacuum conditions. The beamlines' light source is an Apple II-type undulator, which provides soft X-rays in the energy range of 40–2000 eV, delivers a high photon flux of 10^{12} photons/s at 150 eV, and allows for selection of light polarization. With its wide array of techniques based on photoelectron spectroscopy, the PHELIX end station serves as a powerful, versatile tool for investigating complex phenomena in physics and chemistry, including catalysis, magnetism, and materials science.

The PHELIX station provides several techniques for studying the electronic structure of materials: X-ray Photoelectron Spectroscopy (XPS), Angle-Resolved Photoelectron Spectroscopy (ARPES), Spin-Resolved ARPES, and X-ray Absorption Spectroscopy (XAS). Continuous development and the integration of new components guarantee the end station remains ready to address the scientific challenges posed by its user community. Beyond the Phoibos 225 analyzer, a key feature for users is the advanced preparation chamber. This chamber enables molecular beam epitaxy vapor deposition of Fe, Co, and Sn, as well as metallic layer oxidation, gas adsorption, argon ion sputtering, and sample surface quality assessment using low-energy electron diffraction (LEED). Furthermore, the system supports both resistive and electron-beam sample annealing and cooling, preparation of atomically clean surfaces via in-vacuum cleavage (for hard materials) or vacuum exfoliation (for soft 2D materials). To meet evolving scientific demands, the PHELIX station features auxiliary ports for installing user-provided vapor sources, attaching vacuum suitcases, or for integrating the system with an electrochemical cell. Finally, the capabilities of the beamline will expand with the commissioning of a Near-Ambient Pressure XPS (NAP-XPS) branch, scheduled for the first half of 2027.

[1] Szlachetko, J., Szade, J., Beyer, E. *et al.* SOLARIS National Synchrotron Radiation Centre in Krakow, Poland. *Eur. Phys. J. Plus* **138**, 10 (2023). https://doi.org/10.1140/epjp/s13360-022-03592-9

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

ADVANCED MATERIALS RESEARCH AT THE PIRX BEAMLINE

E. Partyka-Jankowska[1], K. Pitala[1], J. Stępień[2] and M. Zając[1,*]

[1]*National Synchrotron Radiation Centre Solaris, Jagiellonian University, Czerwone Maki 98, 30-392 Kraków, Poland*

[2]*AGH University of Science and Technology, Academic Centre for Materials and Nanotechnology, al. Mickiewicza 30, 30-059 Kraków, Poland*

**E-mail: mar.zajac@uj.edu.pl*

The PIRX beamline at the SOLARIS National Synchrotron Radiation Centre serves as a specialized platform for the element-selective measurements of advanced functional materials. By utilizing soft X-ray absorption spectroscopy in the 100–2000 eV energy range, the facility enables researchers to disentangle complex electronic, structural and magnetic features across diverse scientific domains.

In the field of energy storage, the chemical sensitivity inherent to X-ray absorption spectroscopy (XAS) allows for the detailed tracking of redox mechanisms and surface degradation in next-generation battery electrodes, providing a clearer understanding of how surface-bulk interactions govern device longevity using two detection techniques namely Total Electron Yield (TEY) as well as Partial Fluorescence Yield (PFY). For organic electronics, the application of linear dichroism (XLD) facilitates the characterization of molecular uploader and film morphology, which are critical for optimizing charge transport in high-efficiency photovoltaic systems.

The beamline also excels in the study of nanomagnetism and spintronics, where it might be used to probe the interplay between epitaxial strain and interfacial exchange coupling in low-dimensional magnetic heterostructures using circular magnetic dichroism (XMCD). Furthermore, the beamline's ability to adapt its setup and conduct studies under external stimuli allows for the investigation of dynamic spin-state transitions in molecular complexes adsorbed on surfaces, offering insights into the development of future molecular switches.
Moreover the PIRX beamline is also equipped with a preparation chamber that enables in situ preparation and modification of materials.

Together, these studies demonstrate the PIRX beamline's role as a pivotal infrastructure for driving innovation in physics, materials science and spintronics, Beyond these fields, its unique capabilities provide broad opportunities for research across chemistry, catalysis, biological sciences, and medicine.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

THREE-DIMENSIONAL MICROIMAGING WITH ELEMENTAL SENSITIVITY AS A NEW MODALITY OF THE POLYX BEAMLINE AT THE SOLARIS SYNCHROTRON

Filip J. Baran,[1, 2] Paweł Wróbel,[2, 3,*] Katarzyna M. Sowa,[2]
Tomasz Kołodziej,[2] and Paweł Korecki[4]
[1] Doctoral School of Exact and Natural Sciences, Jagiellonian University, 30-348 Krakow, Poland
[2] NSRC SOLARIS, Jagiellonian University, 30-392 Krakow, Poland
[3] Faculty of Physics and Applied Computer Science, AGH University of Krakow, 30-059 Krakow, Poland
[4] Institute of Physics, Jagiellonian University, 30-348 Krakow, Poland
**E-mail: pwrobel@agh.edu.pl*

X-ray fluorescence computed tomography (μXRF-CT) combines the elemental specificity of μXRF spectroscopy with the three-dimensional reconstruction capabilities of μCT to visualise the distribution of specific elements within a sample. The recent experiment at the PolyX beamline 0 at the SOLARIS synchrotron 0, which was conducted in March this year, enabled commissioning of μXRF-CT by measuring gold microspheres and *Arabidopsis thaliana* seed as tomographic standards. Reconstructed cross-sections of the seed are presented in Figure 1. Self-absorption in the sample limits the possibilities for qualitative analysis of sample composition, especially for light elements, but there are algorithms that can correct this effect or even enable quantitative analysis 0. Moreover, correlating and merging data from μXRF-CT and transmission μCT could extend the possibilities for sample characterisation 0. The following step in the process of sharing a new beamline modality with users is implementing self-absorption correction and optimizing experimental conditions. Single-slice data acquisition requires approximately 2 hours, but limiting number of projections and implementing iterative reconstruction algorithms could reduce it several times. Together with developing a workflow for whole experiment it creates a powerful technique modality, which significantly enhances the beamline's capabilities.

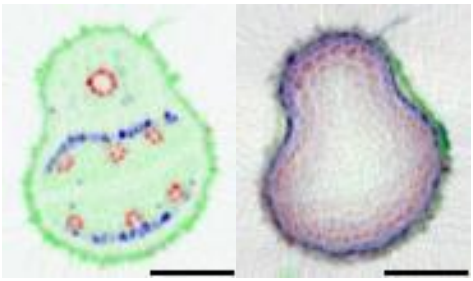


Figure 1. Reconstructed cross-sections of *Arabidopsis thaliana* seed. Left image was constructed with Fe (red), Ca (green), and Mn (blue) signals; right image with P (red), Cl (green), and S (blue) signals. Scale bars length equal to 100 μm.

[1] Sowa et al., Nucl. Instrum. Methods Phys. Res. B: Beam Interact. Mater. At. 538 (2023): 131-137.
[2] Szlachetko et al., Eur. Phys. J. Plus 138.1 (2023): 10.
[3] Huang, Limburg, and Rohtla, AIP Advances 7, 055111 (2017).
[4] Lin et al., Commun Biol 7, 280 (2024)

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

NON-DESTRUCTIVE INVESTIGATION OF MICROPALAEONTOLOGICAL STRUCTURES USING THE POLYX BEAM: APPLICATIONS OF SYNCHROTRON IMAGING IN PALAEOZOIC FISH REMAINS

Darja Dankina[1]*

[1]*The State Scientific Research Institute Nature Research Centre, Vilnius, Lithuania*

**E-mail:* darja.dankina@gmail.com

The investigation of internal anatomical structures in micropalaeontological material is essential for understanding biological development, functional morphology, and evolutionary relationships, particularly when describing new fossil species. Histological analyses provide valuable information about internal tissues, growth patterns, tissue thickness, and developmental processes; however, traditional approaches commonly require mechanical preparation, including grinding and thin-sectioning. These destructive techniques are often unsuitable for rare and unique palaeontological specimens, where preservation of the original material is a priority.

The development of synchrotron-based imaging techniques has significantly changed the possibilities for palaeontological research by enabling high-resolution, non-destructive visualization of internal structures. In this study, the potential of the POLYX Beam at the Solaris Synchrotron Centre in Kraków is evaluated for the investigation of micropalaeontological material, with a particular focus on the internal morphology and histological characteristics of Palaeozoic fish remains. The research explores the application of synchrotron scanning for obtaining detailed datasets suitable for three-dimensional reconstruction and further morphological analysis.

The obtained synchrotron datasets are processed using the open-access 3D visualization software 3D Slicer to generate three-dimensional models and evaluate internal anatomical features without damaging the original specimens. Additionally, the advantages and limitations of synchrotron-based imaging are discussed through comparison with conventional micro-computed tomography (microCT) scans of similar fossil material.

This comparative approach highlights the differences in imaging quality, resolution, and the ability to visualize complex internal structures between the two techniques. The results demonstrate the potential of synchrotron imaging as a powerful tool in modern micropalaeontology, providing new opportunities for studying rare fossil specimens while preserving their integrity. The application of POLYX Beam technology may significantly contribute to future taxonomic, anatomical, and evolutionary studies of exceptionally preserved fossil organisms.

Joint Meeting of Polish Synchrotron Radiation Society Members
and SOLARIS Centre Users

NANOTECHNOLOGY IN CROP PRODUCTION

Kalenska S.*, Novytska N., Sonko R., Garbar L., Honchar L. , Mazurenko B., Kalenskyi V., Shutiy O., Pylypenko V., Antal T. , Kovalenko R.

National University of Life and Envirenmental Sciences of Ukraine;

03041, Kyiv, Ukraine
e-mail: kalenskaya@nubip.edu.ua

Research on nanopreparations has been conducted by the Department of Crop Production at NUBIP Ukraine more than 15 years. The results obtained allow for a generalization of the current understanding and determination of future research directions regarding the multifunctional use of nanopreparations in crop production. The results pertain to the multifunctional effect of nanoparticles on plant growth and development, the process of yield formation and product quality of field crops, the incorporation of the active substance of nanopreparations into plant metabolism and the provision of nutrients to plants, the mechanism for increasing plant resistance to stress and pathogens, seed health improvement, and enhancement of their sowing properties. Nanopreparations in crop cultivation technologies contribute to achieving stable yields using significantly lower fertilizer rates and increasing the efficiency of nutrient uptake. Nanotechnologies in crop production are a promising area: nanofertilizers, activation and increase of photosynthetic productivity, immunocorrectors, antistress agents, nanopesticides, specific root effectors for rooting shoots and tissue cultures, and preparations with multivalent action to increase plant resistance to stress.

The positive effect of replacing nanomicronutrient fertilisers on increasing plant resistance to stress and the formation of generative organs, even under conditions of prolonged drought stress. Replacing no more than 40% of the recommended rate of mineral fertilisers with nano-fertilisers resulted in significantly higher than control levels of the number of beans and seeds per plant and seed weight per plant. Our calculated share of factors in the four-year research (2019-2022) in soybean yield formation showed that the influence of the fertiliser system on the length of the root system reached 59%, which significantly exceeded the influence of the variety (17%), i.e. both mineral and nanofertilisers play a decisive role in soybean root formation. The interaction between variety and fertiliser accounted for 24% of the variation in root length, i.e., variety specificity to fertilisers was evident. This phenomenon was the most important (71%) for the establishment of the lower bean, while fertiliser and variety separately accounted for 20% and 9% of the variation. The number of nodes per plant depended almost equally on the variety (40 %) and the interaction of the variety with fertiliser (41 %), while they had a much smaller effect (19 %). Bean length was equally dependent on fertiliser and the interaction of this factor with the varietal factor, while the participation of the variety alone was insignificant (8%). The role of the varietal factor was significant in the formation of the number of seeds per bean (49%) and the weight of seeds per plant (79%). The share of fertiliser influence on the weight of 1000 seeds was 46%, the varietal factor accounted for 24% of the variation, and their interaction for 30%.

Crucial to these studies is the conduct of high-precision analyses of the quality of nanopreparations and the obtained plant raw materials, which can be significantly aided by synchrotron radiation methods. These studies can support and improve our research.

VERTICALLY COLLIMATING MIRROR INSTALLATION AND COMMISSIONING AT THE POLYX BEAMLINE

Tomasz Kołodziej,[1,*] Katarzyna Sowa,[1] Łukasz Bodek,[3] Paweł Wróbel,[1,2] Filip Baran,[1,4] Marcin Drąg[2], Mateusz Boruchowski[1], Marcel Piszak,[1] Tomasz Zbylut,[1] and Paweł Korecki[3]

[1] *SOLARIS National Synchrotron Radiation Centre, 30-392 Kraków, Poland*

[2] *Faculty of Physics and Applied Computer Science, AGH University of Kraków, 30-059 Kraków, Poland*

[3] *Institute of Physics, Jagiellonian University, 30-348 Kraków, Poland*

[4] *Doctoral School of Exact and Natural Sciences, Jagiellonian University, 30-348 Krakow, Poland*

**E-mail: t.kolodziej@uj.edu.pl*

The PolyX beamline [1] at NSRC SOLARIS [2] is a bending magnet beamline dedicated to μ-spectroscopy and multi-modal X-ray imaging. For X-ray imaging, the μ-CT (μ-computed tomography) and μ-XRF mapping modes, the beamline operate with a white or broad-band/pink beam from a double multilayer monochromator. However, XAFS studies require high photon energy resolution to reveal sharp spectral features in the spectrum. This can be obtained either by limiting the natural divergence of the synchrotron radiation beam with movable apertures, which reduces the flux, or by collimating the beam in the dispersion plane with a grazing-incidence mirror. A 1.13 m-long, cylindrical, dynamically bent mirror was acquired from the Swiss Light Source synchrotron at the Paul Scherrer Institute in Switzerland through a barter agreement in exchange for polycapillary optics and positioning elements. This first required mechanical adaptation due to the different synchrotron radiation beam heights at the two facilities (1400 mm at SLS, 1300 mm at SOLARIS). After adjustments to all subsystems (mechanical, electrical, motorization, vacuum, cooling), the mirror was installed at the beamline and the first commissioning tests with the X-ray beam were conducted. These initial tests showed a significant improvement in XAFS data quality (measured with a copper reference foil). The bandwidth of the beam transmitted through the double-crystal monochromator was inspected with a home-made energy analyzer based on higher-order Bragg reflection from a high-quality silicon single crystal. Initial results show a strong narrowing of the angular divergence of the monochromatized beam when the mirror is set approximately to the collimation condition, which directly translates into a narrowing of the energy bandwidth without a strong loss of flux, as occurs when using apertures.

[1] K.M. Sowa, P. Wróbel, T. Kołodziej, W. Błachucki, F. Kosiorowski, M. Zając, P. Korecki (2023). *PolyX beamline at SOLARIS—Concept and first white beam commissioning results.* NIMB, **538** (131–137).

[2] J. Szlachetko *et al*., (2023). *SOLARIS national synchrotron radiation centre in Krakow, Poland*. The European Physical Journal Plus. **138**. 10.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

INNOVATIVE NANOAQUACHELATE NANOFERTILIZERS IMPROVE PHOTOSYNTHETIC PERFORMANCE, REDOX HOMEOSTASIS AND PRODUCTIVITY OF *HELIANTHUS ANNUUS* L.

Olha Kravchenko*, Viacheslav Chobotar and Nadiia Yashchuk
National University of Life and Environmental Sciences of Ukraine, 03041 Kyiv, Ukraine
**E-mail: olha_kravchenko@nubip.edu.ua*

Sunflower (*Helianthus annuus* L.) is one of the world's major oilseed crops, and improving nutrient use efficiency under increasing climatic stress is essential for sustainable production. Nanoaquachelates are an innovative class of nanofertilizers designed to enhance micronutrient bioavailability and nutrient use efficiency; however, their physiological and molecular mechanisms governing nutrient uptake and stress adaptation remain poorly understood.

The aim of this study was to evaluate the effects of nanoaquachelates on photosynthetic performance, antioxidant metabolism, yield, and seed oil content of sunflower under field conditions.

Field experiments were conducted during 2024-2025 in the Kyiv region (Ukraine). Sunflower hybrid 'Stark' was treated with Cu-Zn (NChel Cu-Zn) and S–Se–I (NChel S-Se-I) nanoaquachelates applied separately or together with an organo-mineral fertilizer (OMD). Photosynthetic performance, catalase (CAT) and peroxidase (POD) activities, seed yield, and oil content were determined using standard physiological and biochemical methods.

Nanoaquachelate application substantially reshaped antioxidant metabolism. Cu–Zn-containing treatments markedly increased peroxidase activity while reducing catalase activity, whereas the combined application of Nanochelates Cu-Zn, S-Se-I, and OMD promoted balanced antioxidant responses and stabilized cellular redox homeostasis.

The combined treatment enhanced photosynthetic efficiency, as indicated by improved chlorophyll fluorescence parameters. Treatment effects depended on environmental conditions. Under drought conditions in 2024, NChel Cu-Zn + OMD produced the greatest yield increase (+30.3% over the control), whereas in 2025 NChel Cu-Zn + NChel S-Se-I + OMD was the most effective (+22.3%). The combined treatment consistently provided the highest productivity and increased seed oil content by 6.8% compared with the untreated control.

The results suggest that combining NChel Cu-Zn with NChel S-Se-I shifts plant responses from controlled oxidative stress toward stable redox homeostasis, resulting in higher productivity and oil accumulation. These findings highlight the potential of nanoaquachelate-based nanofertilizers for climate-smart sunflower production.

Future synchrotron X-ray fluorescence microscopy (SR-XRF) and X-ray absorption spectroscopy (XAS) studies could reveal the localization and chemical speciation of nanoaquachelate-derived micronutrients, providing mechanistic insight into nutrient uptake and redox regulation.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

REGIONAL DIFFERENCES IN FIRMNESS AND MINERAL DISTRIBUTION WITHIN PERSIMMON FRUIT: TOWARDS UNDERSTANDING CELL WALL STRUCTURE USING SYNCHROTRON TECHNIQUES

Ana-Pilar Moreno, Belén Martínez-Alcántara, Ana Pérez-Piqueres, Isabel Rodríguez-Carretero, Ana Quiñones, Julia Morales*

Valencian Institute for Agricultural Research (IVIA), 46113 Moncada, Valencia, Spain

**E-mail: morales_jul@gva.es corresponding/presenting author*

Fruit firmness is one of the most important quality attributes determining the commercial value and postharvest performance of persimmon (*Diospyros kaki* L.). Although firmness is generally evaluated as a single fruit parameter, mechanical properties are not uniformly distributed within the fruit, suggesting the existence of localized structural and physiological differences.

Preliminary studies conducted in our research group revealed distinct firmness gradients within 'Rojo Brillante' persimmon fruit, with the calyx region consistently exhibiting higher firmness than the apical region both at harvest and after cold storage. These mechanical differences were accompanied by regional variations in mineral composition, with calcium, magnesium, manganese and iron predominating in the calyx region, whereas phosphorus, potassium and sulfur accumulated preferentially in the apical region. Such patterns suggest that regional differences in mineral distribution may be associated with local modifications of cell wall organization and tissue architecture.

These findings have opened a new research line aimed at understanding the structural basis of fruit firmness at the tissue level. Synchrotron-based techniques provide an exceptional opportunity to investigate the spatial organization of cell wall components and the in situ localization of mineral elements with high spatial resolution, overcoming the limitations of conventional analytical methods. Combining these approaches with our current physiological and mineral analyses is expected to reveal how cell wall architecture contributes to regional mechanical properties within the fruit.

A better understanding of the relationship between mineral distribution, cell wall structure and tissue firmness will provide new insights into the mechanisms controlling fruit quality and may contribute to the development of improved preharvest strategies for enhancing persimmon firmness and postharvest performance.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

ROUTINE OPERANDO STUDIES WITH NEAR AMBIENT PRESSURE (NAP) - XPS

Liana Socaciu-Siebert
SPECS Surface Nano Analysis GmbH, Voltastrasse 5,13355 Berlin, Germany
E-mail: liana.socaciu-siebert@specs-group.com

Over the last decades it has been possible to develop XPS systems that can work far beyond the standard conditions of high or ultrahigh vacuum. Thus, Near Ambient Pressure (NAP) - XPS has become a rapidly growing field and has demonstrated its capability in a wide variety of applications. Starting from operando studies of surface reactions in catalysis, the applications soon have been extended towards studies of processes at liquid surfaces. Since more than 15 years, the need for basic studies of the fundamental chemistry at solid-liquid interfaces has attracted growing interest. Dip-and-pull experiments at synchrotrons finally demonstrated that in-situ and operando XPS in electrochemical experiments can be realized, significantly contributing to the basic understanding of modern energy converting or storing devices, like batteries, fuel cells, etc.

The development of optimized sample environments, like Peltier coolers, operando electrochemical cells or dip-and-pull configurations opens the possibility for the preparation and analysis of a multitude of liquid samples or solid-liquid interfaces on a reliable daily basis by using laboratory synchrotron systems. Additionally, solutions for extending the available experimental pressure range up to 1 bar have been developed for laboratory and synchrotron systems. The combination of various analysis methods (NAP-XPS, NAP-HAXPES, NAP-SPM, IRRAS, etc.) allows for gaining insights into the fundamental processes that take place during a chemical reaction.

Existing solutions for NAP-XPS/NAP-HAXPES will be presented, with an emphasis on latest developments of instruments and material analysis methods. Examples and results will be shown as well as future perspective of applications and scientific contributions of routine operando NAP-XPS.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

MOBIALD SYSTEM FOR SURFACE SCIENCE STUDIES

Robert P. Socha,[1,*] Ivo Utke,[2], Paweł Budzioch[3], Anna Drabczyk[1], Grzegorz Putynkowski[1]
[1]*CBRTP SA Research and Development Center of Technology for Industry, Zygmunta Modzelewskiego 77 St., 02-679 Warszawa, Poland, Poland*
[2]*EMPA, Swiss Federal Laboratories for Materials Science and Technology, Feuerwerkerstrasse 39, 3602 Thun, Switzerland*
[3]*Measline Sp. z o.o., Piłsudskiego 3, 32-050 Skawina, Poland*
**E-mail: robert.socha@cbrtp.pl*

This paper presents a MobiALD device designed for surface science studies in vacuum conditions. MobiALD delivers a mobile ALD system demonstrator with in-vacuo sample transfer for scientific studies at exactly the place where high and ultrahigh vacuum (HV/UHV) measurement systems are installed i.e. in specialized laboratories or research facilities. The scientific goals comprise the characterization of the nucleation and early-stage growth of Al_2O_3, ZnO, and Cu-oxide on metal and hydroxylated surfaces, specifically how and to which extent adsorption and chemisorption of the ALD gas precursors occurs after every half-cycle of the sequentially supplied ALD gases. These measurements will inform about important aspects of the interface as well as the growing film, such as the oxidation state, the chemical and electronic state of the atoms, and the elemental composition.

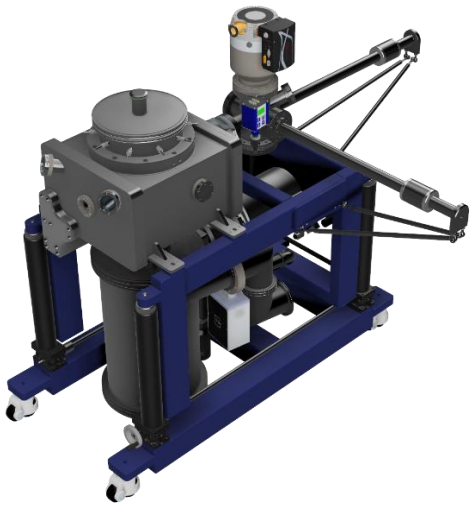


Fig. 1. The MobiALD device

This research was funded by the Swiss–Polish Cooperation Programme within the framework of the Second Swiss Contribution to selected Member States of the European Union, Project No. SPPW/MOBIALD/0086/2024-00.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

POLYX@SOLARIS: BEAMLINE FOR MICROIMAGING AND MICROSPECTROSCOPY

Katarzyna M. Sowa,[1,*] P. Wróbel,[1,2], Tomasz S. Kołodziej[1], Filip J. Baran[1,3] and Paweł Korecki[1,3]

[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*

[2]*Faculty of Physics and Applied Computer Science, AGH University of Krakow, 30-059 Kraków, Poland*

[3]*Doctoral School of Exact and Natural Sciences, Jagiellonian University, 30-348 Krakow, Poland*

[3]*Institute of Physics, Jagiellonian University, 30-348 Krakow, Poland*

**E-mail: k.sowa@uj.edu.pl*

PolyX (polychromatic X-rays and polycapillary X-ray optics [1]) is a bending-magnet beamline at the SOLARIS NSRC in Kraków [2], designed as a compact instrument for micro spectroscopy and multi-modal X-ray microimaging.

The beamline enables 2D/3D structural imaging (radiography, X-ray μCT), elemental mapping (2D μXRF), and chemical phase identification (μXAS/μXES) within one experiment. The beamline operates in three modes: high-flux (DMM, ~2% bandwidth), high-resolution (Si(111) DCM, ~0.02% bandwidth), and a white-beam mode. The accessible energy range (5–15 keV) covers a broad set of K-, L-, and M-edges relevant to energy materials, catalysis, environmental samples, and cultural heritage objects.

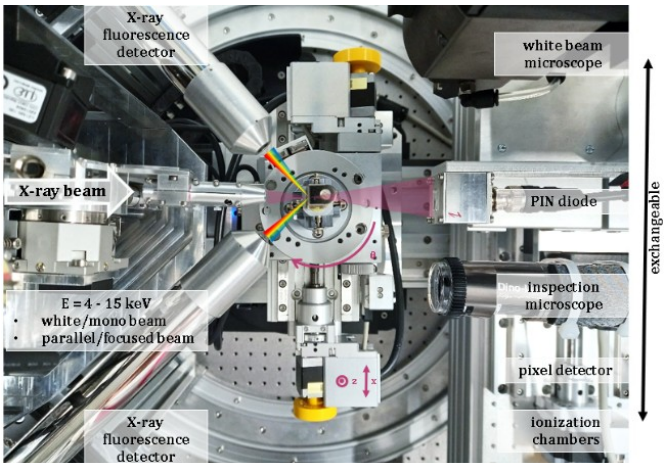


Figure 1 A photo of PolyX experimental setup (top view).

A key feature of PolyX is its (poly)capillary-based focusing concept, which delivers high photon flux into micrometer-scale focal spots (5-100 μm). The end station is built around a reconfigurable experimental setup, enabling rapid transitions between imaging and spectroscopy configurations. PolyX also provides a dedicated area for user-developed experiments and/or custom sample environments. A photograph of the experimental setup is shown in Fig. 1. In this contribution, we present an overview of the beamline design and current status, together with a representative model experiment.

[1] K.M. Sowa, P. Wróbel, T. Kołodziej, W. Błachucki, F. Kosiorowski, M. Zając, P. Korecki (2023). *PolyX beamline at SOLARIS—Concept and first white beam commissioning results*. NIMB, 538 (131–137).

[2] J. Szlachetko et al., (2023). *SOLARIS national synchrotron radiation centre in Krakow, Poland*. The European Physical Journal Plus. 138. 10.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

MARINE WORMS TUBES - XAS INVESTIGATION

Joanna Stępień,[1,*] Katarzyna Berent,[1] and Christian Grenier[1,2]
[1]*AGH University of Krakow, Academic Centre for Materials and Nanotechnology, al. Mickiewicza 30, 30-059 Kraków, Poland*
[2]*Universidad de Granada, Departamento de Estratigrafía y Paleontología, Avenida Fuentenueva s/n, 18071 Granada, Spain*
**E-mail: jstepien@agh.edu.pl*

Serpulid polychaetes construct protective calcium carbonate ($CaCO_3$) tubes composed of calcite, aragonite, or both. microstructural and crystallographic studies have demonstrated that the calcitic phase consists exclusively of medium- to high-Mg calcite (7–15 wt% $MgCO_3$) and that aragonite commonly occurs as a secondary phase replacing pre-existing calcitic microstructures through a recrystallization process [1]. These observations suggest that the calcite-to-aragonite transformation proceeds via a coupled dissolution–reprecipitation mechanism, in which Mg plays a key role in controlling mineral stability and polymorph selection. The instability of the original high-Mg calcite promotes partial dissolution, generating a local Mg-enriched microenvironment that inhibits calcite re-nucleation and favors aragonite precipitation. Quantifying magnesium concentration and distribution within serpulid tubes is critical for testing this hypothesis.

To investigate the role of Mg during this transformation, we performed synchrotron soft X-ray absorption spectroscopy (XAS) at the Mg K-edge on polished cross-sections of serpulid tubes at the PIRX beamline (SOLARIS National Synchrotron Radiation Centre). The investigated regions comprise primary high-Mg calcite, secondary aragonite and their reaction interfaces, previously characterized using SEM/EDS.

Preliminary XAS maps reveal pronounced spatial variations in Mg intensity across calcite–aragonite interfaces. These results provide the first synchrotron-based evidence of Mg redistribution during calcite-to-aragonite replacement in serpulid tubes.

[1] Grenier, C., et al. (2024). Microstructures, crystallography and growth patterns of serpulid tubeworms (Class Polychaeta). Marine Biology, 171(12), 231. DOI: 10.1007/s00227-024-04552-w

SOFT X-RAY PTYCHOGRAPHY AT THE DEMETER BEAMLINE: EXPERIMENTAL MILESTONES, IN-HOUSE DATA MANAGEMENT APPS, AND THE ROAD AHEAD

Wojciech Tomczyk,[1,*] Krzysztof Matlak,[2] Tomasz Strączek[2] and Magdalena Parlińska[1]
[1]*Institute of Nuclear Physics, Polish Academy of Sciences, Kraków, Poland*
[2]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland*
*E-mail: wojciech.tomczyk@ifj.edu.pl; corresponding/presenting author

The DEMETER (Dual Microscopy and Electron Spectroscopy) beamline is a state-of-the-art soft X-ray installation designed for advanced micro-spectroscopy and high-resolution surface characterization. Utilizing an Elliptically Polarizing Undulator (EPU) as its radiation source, the beamline delivers photons with energies ranging from 100 eV to 2000 eV with fully tunable polarization (linear, circular, and elliptical). This flexibility makes it an exceptional tool for studying electronic, structural, and magnetic properties of complex materials, including 2D heterostructures, thin films, and nanomaterials. The beamline features two complementary end-stations: Photoemission Electron Microscopy (PEEM) and Scanning Transmission X-ray Microscopy (STXM).

As part of the subsequent stages of the beamline expansion, the STXM setup has recently been upgraded to enable ptychographic measurements [1], where a probe scans a sample with overlapping positions, recording diffraction patterns at each step. Advanced algorithms then reconstruct high-resolution quantitative images (amplitude and phase) that surpass the resolution of traditional zone plates.

In this contribution, we present a proof-of-concept study utilizing ptychography in the 920 - 960 eV energy range to investigate different morphological forms of copper(I) and copper(II) oxide nanoparticles. Additionally, we introduce in-house software solutions developed to manage research data across the acquisition, processing, and reconstruction stages. Acquired amplitude and phase images demonstrate improved resolution (< 25 nm), quantitative thickness mapping, and chemically sensitive imaging compared to standard STXM, opening new possibilities for nanomaterial and catalysis studies at the SOLARIS facility. Ongoing work focuses on experiments at lower energy regimes (< 300 eV), operando electrochemical studies, and further software optimization.

References

[1] J. Szlachetko *et al.,* Eur. Phys. J. Plus 138, 10 (2023)

Acknowledgements

This research was funded by the grant from the National Science Centre Poland 2023/49/B/ST11/01504 and partially developed under the provision of the Polish Ministry of Science and Higher Education project "Support for research and development with the use of research infrastructure of the National Synchrotron Radiation Centre SOLARIS" under contract no. 1/SOL/2021/2. We are grateful to Benedikt J. Daurer (Diamond Light Source, UK) for helpful discussions regarding PtyPy implementation and optimization procedures. Transmission Electron Microscope images were collected using the equipment purchased within the project "Advanced Microscopic Imaging Laboratory – in-situ Lab" (FEMP.01.04-IZ.00-0259/24), financed by the European Funds for Małopolska 2021–2027.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

OPERANDO CU K-EDGE XAFS REVEALS REVERSIBLE LIGHT-INDUCED CHANGES IN COPPER OXIDE-HEMATITE NANOPARTICLE HETEROJUNCTIONS

Aleksandra Szkudlarek,[1,*] Aleksandra Figura-Jagoda,[1] and Jan Kociścak[2]
[1]*AGH Univeristy of Krakow, 30-059 Krakow, Poland*
[2] *Palacký University Olomouc, 779 00 Olomouc, Czech Republic*
**E-mail: aleszkud@agh.edu.pl*

Understanding light-induced charge transfer and electronic processes in semiconductor heterojunctions requires element-specific techniques capable of probing materials under operating conditions. CuO/Fe_2O_3 heterojunctions are promising functional oxide systems in which interfacial charge redistribution may influence the local electronic structure and chemical state of individual components. However, conventional optical and electrical techniques do not allow direct identification of element-specific changes occurring under illumination. Here, we report preliminary operando Cu K-edge XAFS measurements of aqueous CuO/Fe_2O_3 nanoparticle suspensions performed at the POLYX beamline of the SOLARIS National Synchrotron Radiation Centre.

The nanoparticle suspensions were measured in fluorescence mode in thin-walled capillaries under alternating laser OFF and ON conditions using a 408 nm continuous-wave laser (~5 mW). A clear and reproducible light-induced modulation of the Cu K-edge XAFS spectra was observed in the illuminated region, with the most pronounced changes in the near-edge region. Illumination resulted in a decrease in the white-line intensity, followed by its recovery after switching the laser off. The effect was observed for both shorter and longer acquisitions and showed gradual relaxation during repeated illumination cycles.

The reversible response indicates a light-induced modification of the local electronic structure of Cu. While the decrease in white-line intensity may be consistent with changes in the Cu electronic state, including possible partial reduction, the underlying mechanism remains to be established. The present results demonstrate a clear and reproducible light-induced response at the Cu K-edge under operando conditions. Further systematic XAFS measurements using CuO and Cu_2O reference systems and controlled illumination and X-ray exposure conditions will be performed to establish the origin and mechanism of this effect and to distinguish between photoinduced and light-assisted processes.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS AND SOLARIS CENTRE USERS

VOID FORMATION, SWELLING AND DISAPPEARANCE IN A HIGH ENTROPY METAL ALLOY UPON HIGH ENERGY ION IRRADIATION

Maciej Zieliński[*1], Małgorzata Frelek-Kozak[1], Mathieu Traversier[2], Pavol Noga[3], Tomasz Stasiak[1], Anna Frankiewicz[2], Łukasz Kurpaska[1]

[1] NOMATEN Centre for Excellence - National Centre for Nuclear Research, 7 A. Soltana Street, 05-400 Otwock-Swierk, Poland

[2] Ecole des MINES de St-Ethienne, 158 cours Fauriel, 42023 Saint-Étienne cedex 2,France

[3] Faculty of materials science and technology in Trnava, Advanced technologies research institute, Slovak University of Technology, Vazovova 5, 812 43 Bratislava 1, Slovak Republic

*E-mail: maciej.zielinski@ncbj.gov.pl**

Metal construction materials designed to be applied in the new generation IV of nuclear reactors need to withstand extreme conditions, among which there is neutron irradiation [1,2]. High doses of neutrons subjected to the object that cannot be replaced throughout the long years of operation lead to extensive structure damage [3]. The damage level upon accepting the representative dose of high energy particles has to be characterised prior to certifying the material for its application [4]. The two important phenomena being investigated in this research are: the voids and the dislocations life cycles that are non-linear functions of the fluence of particles implanted in the material [5]. Namely, the concentration and size of individual defects do not increase monotonously with the total dose. As thorough investigation of the observed phenomena is vital, several analytical methods including synchrotron-based techniques that address this topic are evaluated and compared.

[1] *J. Nucl. Mater.*, 617 (2025) 156131, “Mechanical properties, 475°C embrittlement and irradiation resistance of FeCrAl-Y_2O_3 ODS alloy with Ti and V alloying additions”
[2] *Mater. Charact.*, 203 (2023) 113060; “The effects of high-temperature ion-irradiation on early-stage grain boundaries serrations formation in Ni-based alloys”
[3] *Appl. Surf. Sci.*, 610 (2023) 155465, “Mechanical behavior of ion-irradiated ODS RAF steels strengthened with different types of refractory oxides”
[4] *J. Mater. Res. Technol.*, 37 (2025) 5448-5464; “High-temperature radiation resistance of NiCoFe medium-entropy alloy enabled by stable nanostructures and defect evolution mechanisms”
[5] *Nucl. Instrum. Methods Phys. Res., Sect. B*, 540 (2023) 24-29; “High versus low energy ion irradiation impact on functional properties of PLD-grown alumina coatings”

Acknowledgement:

Research was funded: through the European Union Horizon 2020 research and innovation program under Grant Agreement No. 857470; the initiative of the Ministry of Science and Higher Education 'Support for the activities of Centers of Excellence established in Poland under the Horizon 2020 program' under agreement No. MEiN/2023/DIR/3795; the INNUMAT project (Grant Agreement No. 101061241) and EURATOM programme OFFERR - eurOpean platForm For accEssing nucleaR R&d facilities (topic: HORIZON-EURATOM-2021-NRT-01-12)

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

XRRModeler: A computational approach to simulating and fitting X-Ray Reflectivity curves in multilayer structures

R. Stachura[1,2], P. Jagodziński[1,2], D. Banaś[1,3], W. Biela-Nowaczyk[1], I. Stabrawa[1,3], A. Kubala-Kukuś[1,3], K. Szary[1,3], G. Wesołowski[1], G. Aquilanti[4], I. Božičević Mihalić[5], I. Carlomagno[6], J. R. Herrera[6]

(1) Institute of Physics, Jan Kochanowski University, Uniwersytecka 7, 25-406 Kielce, Poland,
(2) Central Office of Measures, Elektoralna 2, 00-139 Warszawa, Poland
(3) Holycross Cancer Center, Artwińskiego 3, 25-734 Kielce, Poland
(4) The International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A-1400 Vienna, Austria
(5) Rudjer Boskovic Institute, Bijenicka cesta 54, 10000 Zagreb, Croatia
(6) Elettra - Sincrotrone Trieste, s.s. 14, km 163.5 in Area Science Park, 34149 Basovizza, Trieste, Italy

X-ray reflectometry (XRR) is a powerful and non-destructive technique commonly employed to investigate thin films and multilayer systems with nanometer-scale thicknesses. It provides quantitative information on structural parameters such as layer thickness, mass density, and interface roughness by analyzing the angular dependence of X-rays reflected from a sample surface [1–3]. The reflectivity curve is strongly correlated with the electron density profile, enabling precise determination of structural properties in single- and multilayer systems [4].

This work presents **XRRModeler**, a software tool developed for the simulation and analysis of XRR data from layered materials. The software employs the **Parratt recursive algorithm** to calculate theoretical reflectivity profiles, taking into account layer thickness, mass density, and interface roughness. A key feature is **chi-square minimization** of calculated profiles against experimental data, enabling quantitative optimization of structural model parameters [5]. XRRModeler supports the analysis of single- and multilayer systems and allows simulation and fitting results to be exported for further analysis. Experimental reflectivity curves of metallic nanolayers, obtained at the XRF beamline at **Elettra Sincrotrone Trieste (Italy)**, were used to demonstrate the fitting capabilities.

XRRModeler provides a computational environment for XRR data interpretation, supporting research in thin-film technology, nanostructured materials, and advanced functional coatings.

Acknowledgements: This work was co-financed by the Minister of Science under the "Regional Excellence Initiative" program (project no. RID/SP/0015/2024/01). The facility functioning is supported by the Polish Ministry of Education and Science (project 28/489259/SPUB/SP/2021).

[1] L. G. Parratt, Phys. Rev. (95), 1954, 359-369.
[2] R. Klockenkamper, A. Von Bohlen, John Wiley & Sons, 2014.
[3] M. Tolan, Springer Berlin Heidelberg, 1999.
[4] Y. Fujii, J. Mater. Sci., (2013), 2013, 1-20.
[5] E. Chason., T. M. Mayer, T., Crit. Rev. Solid State Mater. Sci., 22(1), 1997, 1–67.

JOINT MEETING OF POLISH SYNCHROTRON RADIATION SOCIETY MEMBERS
AND SOLARIS CENTRE USERS

TERNARY IRON CHALCOGENIDES AS HOST MATERIALS FOR ALKYLAMMONIUM-ION INTERCALATION TOWARD POTENTIAL ELECTRODE MATERIALS

Tomasz Chabło, Anna Krztoń-Maziopa
Faculty of Chemistry, Warsaw University of Technology,
Noakowskiego 3, 00-664 Warsaw, Poland
E-mail: tomasz.chablo.dokt@pw.edu.pl

Iron chalcogenides (FeX, X = S, Se, or Te) are promising electrode and solid electrolyte materials for advanced energy-storage systems due to their electrical conductivity, low ion-diffusion barriers, and high theoretical specific capacities [1]. Among them, tetragonal iron sulfide (*t*-FeS) is particularly attractive because of its layered crystal structure, featuring weak interlayer interactions and a relatively large van der Waals gap (~2.6 Å). This open structure facilitates ions insertion and their migration between Fe–S layers, while the high theoretical specific capacity, reaching ~610 mAh g^{-1}, and low cost of raw materials further support its potential for electrochemical applications [2]. However, the practical application of *t*-FeS is limited by difficulties in obtaining phase-pure material due to its narrow compositional stability range and demanding synthesis conditions (mainly solvothermal). Tetragonal phase of FeS is characterized by relatively low electrical conductivity compared to other iron chalcogenides that may also restrict electrochemical performance. Moreover, the mechanisms underlying alkylammonium ions intercalation remain insufficiently understood. Partial substitution of S with Se offers a potential strategy for modifying the crystal structure, electronic properties, and ion-transport characteristics of *t*-FeS [3].

In this study, Se-doped *t*-FeS was investigated as a potential electrode material for alkylammonium-ion batteries. High-temperature synthesis was employed to obtain host materials with different selenium content in anion sublattice, followed by systematic characterization of their composition, phase purity, morphology, and electrochemical properties. The focus of this study was to examine the effect of Se doping on the crystal structure, electrical conductivity, and alkylammonium-ions electrointercalation processes, providing valuable insight into the structure-property relationships governing ion storage in ternary iron chalcogenides.

References:

[1] *J. Mater. Chem. A* (2022) 10 (14): 7517–7556.
[2] *Chem. Mater.* (2020) 32 (21): 9147–9154.
[3] *Adv. Funct. Mater.* (2025), 35, 2420840.

Acknowledgments

Access of Polish researchers to the European Synchrotron, European XFEL, and SOLARIS is supported by projects of the Ministry of Science and Higher Education, Poland. The following presentations of the JMSU 2026 are supported by these projects.

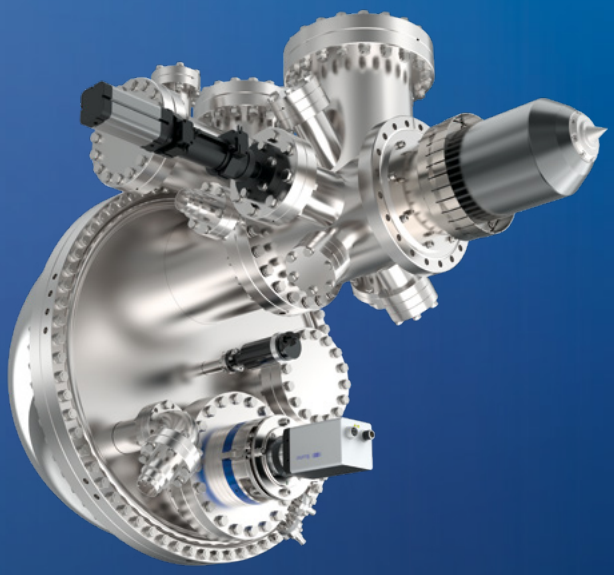
1/SOL/2021/2: I-1, I-3, I-4, I-6, I-7, I-8, O-02, O-06, O-06, O-07, O-08, O-09, O-10, O-11, O-14, O-16, O-17, O-19, O-25, O-26, P-01, P-02, P-03, P-04, P-05, P-06, P-07, P-08, P-09, P-10, P-11, P-12, P-13, P-14, P-15, P-16, P-17, P-18, P-19, P-20, P-21, P-22, P-23, P-24, P-25, P-26, P-27, P-28, P-29, P-30, P-31, P-32, P-33, P-34, P-35, P-36, P-37, P-39, P-40, P-41, P-42, P-44, P-49, P-50, P-51

2021/WK/11: I-7, O-04, O-05, O-12, O-26, O-27

2022/WK/13: I-2, I-5, O-03

Advanced Electron Analysers

OPTIMISED FOR (NAP)-XPS / HAXPES, ARPES AND SPECTRO-MICROSCOPY



AEOLOS 150

- Transmission-optimized design
- Operation up to 10 keV
- Puls counting AD-CMOS detector
- For XPS, HAXPES, NAP-XPS and NAP-HAXPES

NanoESCA • MARIS

- Fully modular instrument
- Lateral resolution < 35 nm
- Momentum space resolution better than 5 $mÅ^{-1}$
- PEEM, MM and ARPES operation
- Imaging spin filter optional

ASTRAIOS 190

- Single spot parallel shifting lens
- Acceptance angle ± 30°
- Energy resolution < 1.5 meV
- Motorized entrance slit
- All ARPES types, including spin

SPECS Surface Nano Analysis GmbH

T +49 30 46 78 24-0
E info@specs-group.com
H www.specs-group.com

SPECSGROUP

polish synchrotron
radiation society

SOLARIS
NATIONAL SYNCHROTRON
RADIATION CENTRE

SYNCHROTRON RADIATION IN NATURAL SCIENCE

Bulletin of the Polish Synchrotron Radiation Society

Vol. 27, 2026

ISSN 3072-5321