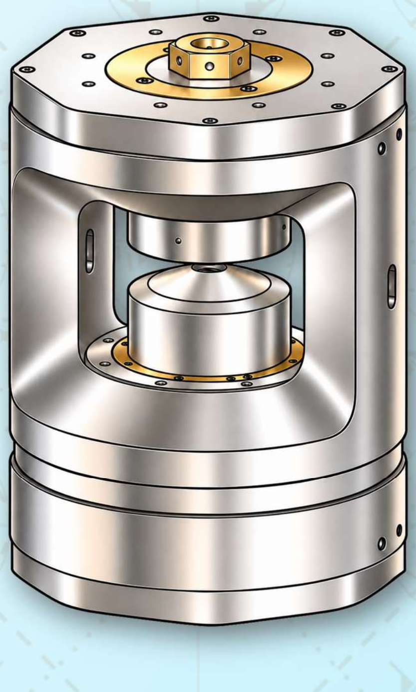
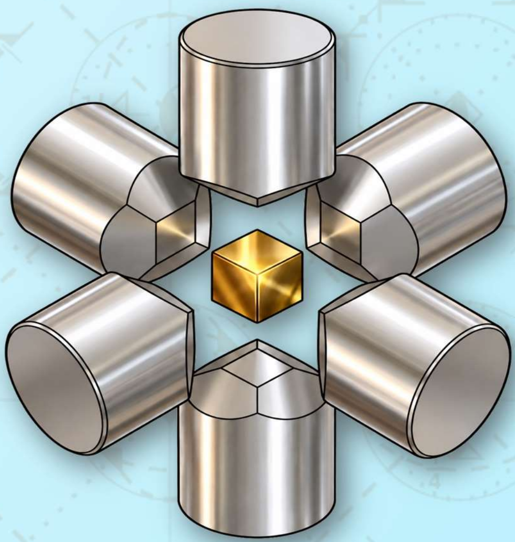
2026 International Workshop on High Pressure Science

高壓科學工作坊





高壓合成與量測技術秋季學校

以壓力拓展材料邊界 從結構解析極端世界

壓力，以及溫度、磁場、化學組成，都是理解物質性質的重要調控參數，而高壓技術讓我們得以推動材料脫離常規環境，進入新的結構與物性空間，推進探索材料研究邊界。高壓技術長期應用於地球科學與行星科學，不僅模擬地球深部與行星內部的極端環境，同時也在凝態物理、化學、材料科學與結晶學扮演關鍵角色，能夠實現常壓下難以穩定存在的亞穩態物質，或探索壓力誘發的相變化等等。透過壓力調控，能在不改變材料化學組成的情況下，連續調控原子間距、晶體結構與電子狀態，對材料的磁性、導電性、超導性、光學性質與化學鍵結都可能發生顯著變化，並誘發常壓下難以觀察的相變與新穎物性，進一步拓展功能性材料與量子材料的研究與發展。

材料的結構資訊是理解其物理與化學性質的核心，而利用 X 光射源與中子源的單晶與粉末繞射技術，則是解析材料晶體結構最基本且強大的工具。當高壓及變溫環境與繞射技術結合，我們得以直接觀察材料在壓力與溫度作用下的結構演化、相變機制與電子結構變化，進一步建立晶體結構與物理性質之間的關聯。然而，高壓繞射實驗受限於光源種類、光斑尺寸、高壓裝置幾何限制、樣品體積與數據收集條件，仍具有相當高的技術門檻，也因此需要跨領域的知識整合與實作經驗。

本工作坊是國內少數全面聚焦於高壓技術與壓力效應的跨領域學術活動，邀請來自國內外高壓科學、凝態物理、地球科學、材料科學、結晶學，以及同步輻射與中子設施等領域的專家學者共同參與。三天的密集課程將聚焦**大壓力機（LVP）**、**鑽石高壓砧（DAC）**與**單晶 X 光繞射（SC-XRD）**技術，結合專題演講、技術課程、交流討論與實作訓練，期望透過本次工作坊，促進不同研究社群之間的連結，推廣高壓科學於各領域的應用，並培育更多年輕研究人才投入高壓技術與壓力效應相關研究。

高壓科學研究會
HPSciReA

Beyond Ambient Conditions: Materials, Structures, and Extreme Worlds

Pressure, alongside temperature, magnetic field, and chemical composition, is one of the fundamental variables through which the properties of matter can be understood, tuned, and transformed. By pushing materials beyond ambient conditions, high-pressure techniques open access to structural and electronic regimes that are otherwise unreachable. They have long been central to Earth and planetary sciences, where pressure is indispensable for reproducing the extreme environments of deep planetary interiors. High pressure is also a powerful tool in condensed matter physics, chemistry, materials science, and crystallography, enabling the synthesis of metastable phases, the control of bonding and coordination environments, and the exploration of phase transitions inaccessible through conventional thermodynamic pathways.

A distinctive strength of pressure is that it can continuously modify interatomic distances, crystal structures, and electronic states without changing chemical composition. This makes it possible to disentangle structural and electronic effects and to examine how magnetism, transport, superconductivity, optical response, and chemical bonding evolve under controlled compression. In this sense, high pressure is not only a means to reach extreme environments, but also a route to materials discovery—revealing emergent properties, stabilizing hidden phases, and expanding the design frontier for functional and quantum materials.

Structural characterization is central to this endeavor. Single-crystal and powder diffraction using X-ray and neutron sources remain among the most powerful methods for resolving atomic arrangements, symmetry, distortions, and phase evolution. When combined with high-pressure and variable-temperature environments, diffraction measurements provide direct insight into how crystal structures respond to external stimuli and how those structural changes are coupled to electronic configuration and physical properties. At the same time, high-pressure diffraction is experimentally demanding. Beam size, radiation source, pressure-cell geometry, sample volume, accessible reciprocal space, and data-collection strategy all place stringent constraints on measurement design and data interpretation.

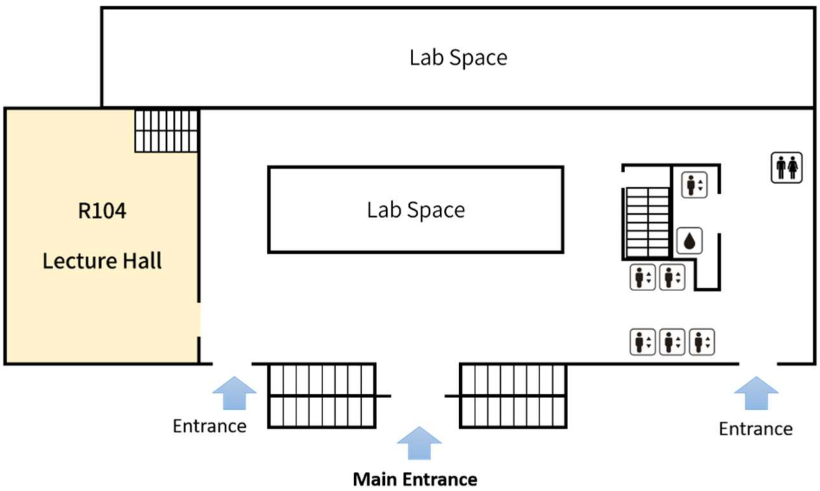
This workshop is designed to provide an integrated forum for these topics. As one of the few interdisciplinary academic events in Taiwan devoted broadly to high-pressure techniques and pressure-induced phenomena, it brings together domestic and international researchers and technical experts in high-pressure science, condensed matter physics, Earth sciences, materials science, crystallography, and large-scale synchrotron and neutron facilities. The three-day program will focus on **Large-Volume Press (LVP)**, **Diamond Anvil Cell (DAC)**, and **Single-Crystal X-ray Diffraction (SC-XRD)** techniques. Through invited lectures, technical courses, scientific discussions, and hands-on practical sessions, the workshop aims to strengthen the connections across research communities, broaden the use of high-pressure techniques, and provide young researchers with the conceptual background and practical skills needed to enter this technically challenging and scientifically rich field.

高壓科學工作坊 [高壓合成與量測技術秋季學校]

International Workshop on High Pressure Science

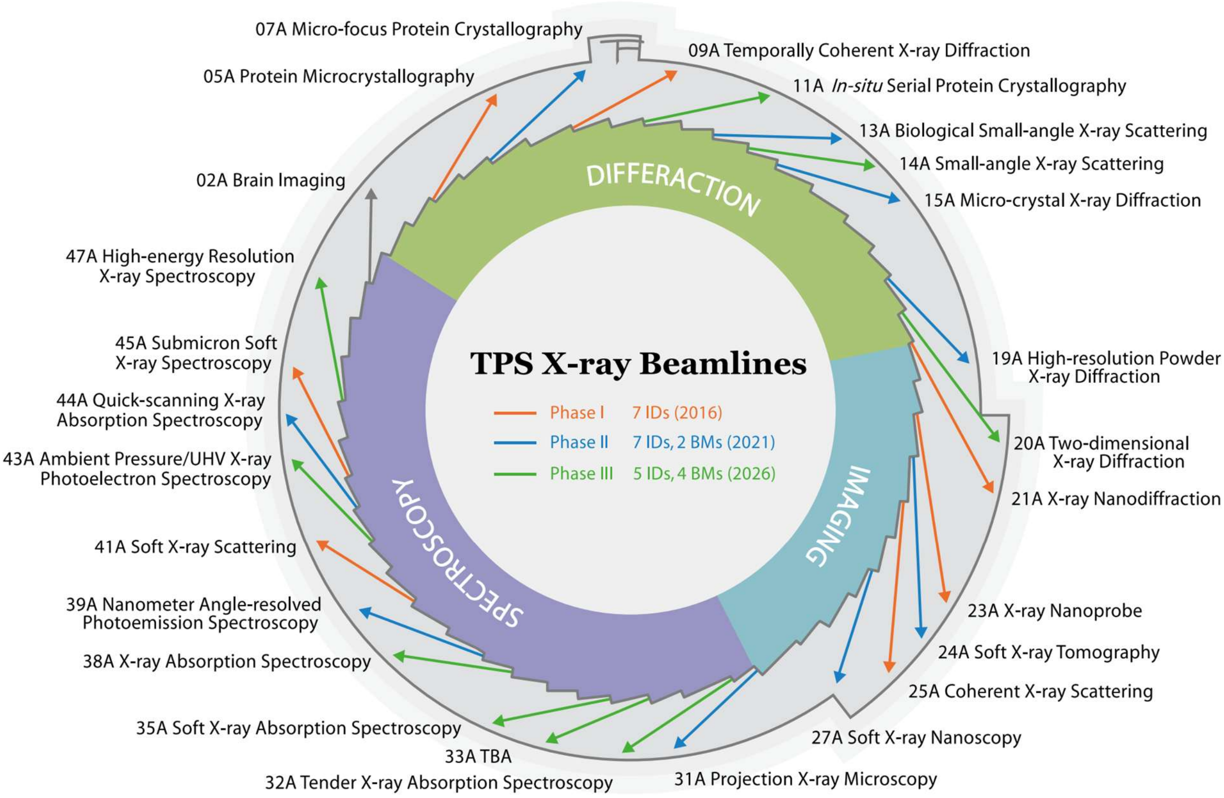
Autumn School for High Pressure Techniques – Synthesis and Characterization

Venue



國家同步輻射研究中心 台灣光子源

Taiwan Photon Source (TPS) Tour for Invited Speakers



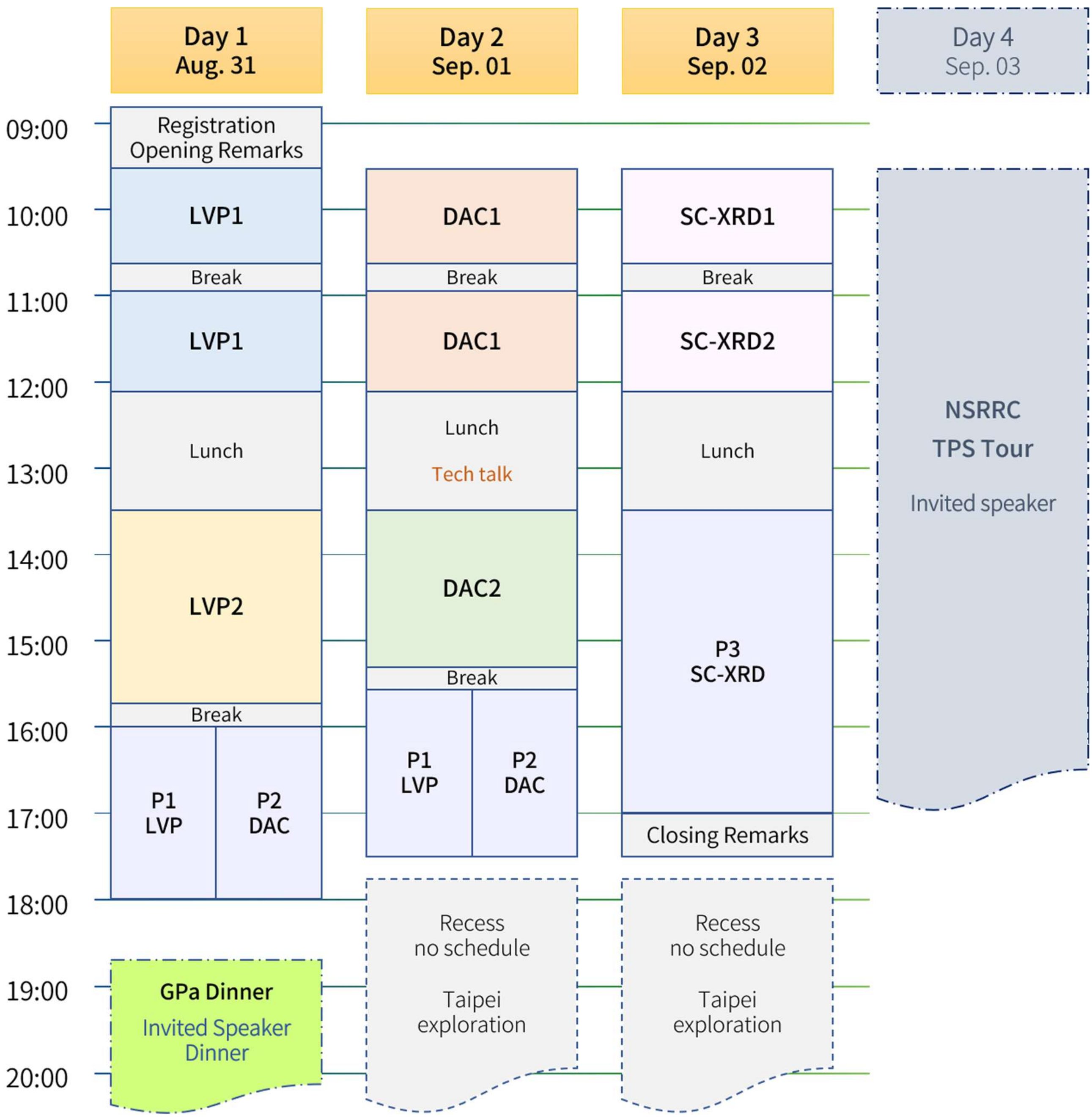
*Phase III is under construction.

高壓科學工作坊 [高壓合成與量測技術秋季學校]

International Workshop on High Pressure Science

Autumn School for High Pressure Techniques – Synthesis and Characterization

Program Overview



Aug 31 (Mon) LVP 1
大壓力機與新穎材料合成 Large Volume Press and Novel Materials Synthesis

09:30-10:05	High Pressure Synthesis of Novel Quadruple Perovskites with Peculiar Charge, Orbital and Magnetic Ordering 陳威廷 Wei-Tin Chen (CCMS, NTU)	P.9
10:05-10:40	High Pressure Synthesis of Hard and Tough Materials: Oxides, Nitrides, and Metals 西山宣正 Norimasa Nishiyama (MANA, NIMS)	P.10
10:40-10:55	Break	
10:55-11:30	Discovery of Novel Superconductor via High-Pressure Synthesis Technique 金民祐 Minu Kim (Dep. Phys, Chung-Ang U.)	P.11
11:30-12:05	High-Pressure Synthesis and V–V Dimerization in Ilmenite-Type Vanadium Oxides 山本孟 Hajime Yamamoto (IMRAM, Tohoku U.)	P.12

Aug 31 (Mon) LVP 2
大壓力機與量測技術 Large Volume Press and X-ray/Neutron Characterization

13:30-14:05	Large-Volume High-Pressure Research Using in-situ Synchrotron X-ray Techniques at GSECARS, Advanced Photon Source 余國彥 Tony Yu (APS, U. Chicago)	P.13
14:05-14:40	Large-Volume Press–Synchrotron Techniques for In Situ Measurements of Phase Transitions and Elasticity 龔慧貞 Jennifer Kung (Dep. ES, NCKU)	P.14
14:40-15:15	Basic Idea to Make New High-P Devices for Single Crystal/ Powder × X-ray/Neutron Diffraction at High/Low-T Conditions 小松一生 Kazuki Komatsu (GcRC, U. Tokyo)	P.15
15:15-15:50	Neutron Diffraction from the Big and the Small Christopher Ridley (SNS, ORNL)	P.16

Sep 01 (Tue) DAC 1
鑽石高壓砧與量測技術 Diamond Anvil Cell and Characterization

09:30-10:05	Experimental Constraints on the Thermal Structures in Earth and Planetary Interiors: Global and Regional 謝文斌 Wen-Pin Hsieh (IES, AS) P.17
10:05-10:40	Integrated DAC Capabilities at GSECARS for Structural, Vibrational, and Elastic Studies under HP-HT Conditions 柳榮濟 Young Jay Ryu (APS, U. Chicago) P.18
10:40-10:55	Break
10:55-11:30	Strain-Induced New Superconducting Phase in Crystal-GeTe 歐敏男 Min-Nan Ou (IOP, AS) P.19
11:30-12:05	High-Pressure Synthesis and Diamond Anvil Cell Investigation of NIR–SWIR Infrared Emission Transformation 方牧懷 Mu-Huai Fang (RCAS, AS) P.20

午餐技術短講 Lunch Tech Talk

12:15-12:45	Application of X-ray Absorption Spectroscopy with a Laboratory X-ray Powder Diffractometer 李秉中 Plex Lee (Malvern Panalytical) P.36

Sep 01 (Tue) DAC 2
實驗室高壓量測技術 Laboratory High Pressure Characterization

13:30-14:05	Pressure as a Continuous Tuning Knob for Interlayer Electronic Coupling in Two-Dimensional van der Waals Materials 徐瑋廷 Wei-Ting Hsu (Dep. Phys, NTHU) P.21
14:05-14:40	Pressure Effect on Superconductivity and Strongly Correlated Systems 黃建龍 Chien-Lung Huang (Dep. Phys, NCKU) P.22
14:40-15:15	Rational Synthesis of Novel Carbon Networks via Crystal Engineering 黃晧庭 Haw-Tyng Huang (Dep. MSE, NTU) P.23

Sep 02 (Wed) SC 1 **X 光單晶繞射技術 Single Crystal X-ray Diffraction Techniques**	
09:30-10:05	The Status of TPS 15A, micro-Crystal X-ray Diffraction Beamline 吳來錦 Lai-Chin Wu (NSRRC) P.24
10:05-10:40	Non-Ambient Single Crystal X-ray Diffraction Beamline at TPS 李之釗 Jey-Jau Lee (NSRRC) P.25
10:40-10:55	Break
10:55-11:20	Structural Analysis of Single Crystals under High Pressure 洪慈蓮 Tsu-Lien Hung (NCKU) P.26
11:20-11:45	APEX6 – User-Friendly and Robust Solutions for Single-Crystal X-ray Diffraction, Including High-Pressure Applications 楊雅晴 Ya-Ching Yang (Bruker) P.27
11:45-12:05	High-Pressure Crystallography on Concurrent Home Laboratory Instruments Christian Göb (Rigaku) P.28

Aug 31 (Mon) and Sep 01 (Tue) P1/P2 **示範與實作 Demonstration and practice (LVP and DAC groups)**		
LVP Group	Demonstrator: 劉恩沛、謝文鈺、許嘉翔、李秉祐、陳威廷	R720、B102
DAC Group	Demonstrator: 洪慈蓮、陳朝志、林俊宏、曹懿麒 張仁韋、鄭博元、陳彥彰、Christian Göb	R104、R720

Sep 02 (Wed) P3 **示範與實作 Demonstration and practice: SC-XRD**		
APEX	楊雅晴 Ya-Ching Yang (Bruker)	R104
CAP	Christian Göb、廖健宏 Vincent Liao (Rigaku)	R212
X-AREA	Arnaud Grosjean (NSRRC)	R903

High Pressure Synthesis of Novel Quadruple Perovskites with Peculiar Charge, Orbital and Magnetic Ordering

Wei-Tin Chen,[1,2,3] En-Pei Liu,[1,4] Wen-Yu Hsieh[1,2]

[1]*Center for Condensed Matter Sciences, National Taiwan University*
[2]*Center of Atomic Initiative for New Materials, National Taiwan University*
[3]*Taiwan Consortium of Emergent Crystalline Materials, National Science and Technology Council*
[4]*Department of Physics, National Taiwan University*

Novel functional materials design and discovery for magnetic, electronic, spintronic and energy technology applications stimulate much of modern chemistry, physics and materials science. Such materials are of particular interests due to their correlated electron systems ground states, and the sensitivity to changes in chemical composition and physical conditions. High pressure high temperature (HPHT) synthesis technique is one of the most important approaches in the novel materials exploration, that the extreme conditions are especially beneficial to realise metastable phases with exotic properties. For instance, $CaMn_7O_{12}$ (CMO) belongs to the quadruple perovskite family and was reported as Type-II multiferroic with large magnetoelectric response and intriguing orbital ordering.[1] Recently, novel analogue $HgMn_7O_{12}$ (HMO) and a series of A-site-ordered quadruple perovskite was successfully synthesised by HPHT synthesis techniques.[2] In addition to the charge ordering (CO) observed in CMO, HMO experiences a further symmetry-lowering phase transition and exhibits multiferroicity at low temperature. Furthermore, A-site aliovalent doping with Na cation introduces competition between charge and orbital ordering modes.[3,4] In this presentation, various mercury perovskite oxide materials with their peculiar behaviours such as structural distortion and phase transition, charge/orbital/spin ordering and physical properties will be discussed.

References:

1. R. D. Johnson* *et al.*, *PRL* **108**, 067201 (2012)
2. W.-T. Chen, M. Senn* *et al.*, *PRB* **97**, 144102 (2018); W.-T. Chen *et al.*, *Nat. Commun.*, **12**, 6319 (2021)
3. B. R. M. Tragheim, M. Senn,* W.-T. Chen* *et al.*, *PRB* **110**, 245123 (2024)
4. B. R. M. Tragheim, M. Senn,* W.-T. Chen* *et al.*, *PRB* **113**, 104425 (2026)

Dr. Wei-Tin Chen (陳威廷), Associate Research Fellow
Center for Condensed Matter Sciences, National Taiwan University
Email: weitinchen@ntu.edu.tw

Research interests: (1) High pressure sciences and techniques; (2) Solid state chemistry and physics; (3) Crystallography and symmetry-adapted analysis; (4) Structural and magnetic phase transitions.

High pressure synthesis of hard and tough materials: oxides, nitrides, and metals

Norimasa Nishiyama

Research Center for Materials Nanoarchitechtonics, National Institute for Materials Science

High-pressure synthesis techniques can produce mechanically hard and tough materials. These materials are thermodynamically stable under high-pressure and high-temperature conditions, but remain metastable at ambient pressure and room temperature. Diamond, a high-pressure phase of carbon, is the most famous example. Here, I would like to introduce three other examples that have strong potential for industrial use: nanopolycrystalline stishovite[1] (SiO_2), cubic silicon nitride[2] (Si_3N_4), and omega titanium[3] (Ti).

Stishovite, a high-pressure polymorph of SiO_2, is known as the hardest oxide. We fabricated nanopolycrystalline stishovite. This material exhibits a fracture toughness comparable to that of zirconia. At the fracture surfaces, we observed a stress-induced phase transformation from stishovite to amorphous silica accompanied by a large volume expansion[1]. Through bending tests and theoretical calculations, we demonstrated that a transformation-toughening mechanism operates at the nanometer scale.

Silicon nitride is one of the most widely used structural ceramics in industry. We fabricated transparent polycrystalline cubic silicon nitride under high-pressure and high-temperature conditions. This material is regarded as the third-hardest known material and exhibits excellent thermal stability in air up to 1400°C. It therefore has potential for use as a window material in harsh environments.

Titanium is widely used in biomedical applications such as implant devices. We fabricated polycrystalline omega titanium, a high-pressure phase of titanium. This material is significantly stronger than alpha titanium, which is stable under ambient conditions, while maintaining an elongation to failure of approximately 20%. We demonstrated that transformation-induced plasticity is activated in this material, providing an unusual combination of high strength and high ductility.

References:
1. N. Nishiyama *et al.*, *Sci. Rep.* **4**, 6558 (2014).
2. N. Nishiyama *et al.*, *Sci. Rep.* **7**, 44755 (2017).
3. N. Nishiyama *et al.*, *Sci. Rep.* **16**, 5395 (2026).

Dr. Norimasa Nishiyama (西山宣正), Group Leader
Research Center for Materials Nanoarchitechtonics,
National Institute for Materials Science (NIMS)
Email: nishiyama.norimasa@nims.go.jp
Research interests: (1) High-pressure materials science; (2) mechanical properties; (3) transparent materials; (4) synchrotron radiation

Discovery of Novel Superconductor via High-Pressure Synthesis Technique

Minu Kim

Department of Physics, Chung-Ang University, Seoul, South Korea

The recent discovery of superconductors with exceptionally high transition temperatures (T_c) has garnered significant attention from both the scientific community and the general public, opening new avenues for superconductivity research. Among various methodologies, high-pressure techniques have emerged as a powerful and versatile tool for investigating novel materials and synthesizing superconductors that are inaccessible under ambient conditions. In this presentation, I will discuss my previous work on the synthesis of new perovskite oxide superconductors utilizing high-temperature high-pressure techniques, specifically employing a Walker-type multi-anvil apparatus.[1] Building on this, I will elaborate on the strategic manipulation of charge-transfer energy and metal-oxygen covalency, which represent promising pathways for the discovery of next-generation superconductors with unique and transformative properties. Finally, I will introduce my ongoing effort to establish one of the first high-pressure synthesis laboratories in South Korea, and share the current progress toward fostering new research opportunities and collaborations within the international high-pressure community.

References:

1. M. Kim *et al.*, "Superconductivity in $(Ba,K)SbO_3$", *Nat. Mater.* **21**, 627 (2022).

Porf. Minu Kim (金民祐), Assistant Professor

Department of Physics, Chung-Ang University, Seoul, South Korea

Email: minukim@cau.ac.kr

Research interests: (1) High-pressure synthesis of quantum materials; (2) Solid state physics and strongly correlated electron systems; (3) Oxide thin films and heterostructures; (4) Superconductivity

High-Pressure Synthesis and V–V Dimerization in Ilmenite-Type Vanadium Oxides

Hajime Yamamoto

Institute of Multidisciplinary Research for Advanced Materials, Tohoku University

Cation dimerization, or multimerization, refers to the formation of direct chemical bonds between neighboring cations in crystalline compounds. This phenomenon is well known in the Peierls transition of VO_2 and has attracted considerable interest in both solid-state physics and chemistry. Recently, we observed V–V dimerization in ilmenite-type $MgVO_3$, which is synthesized under high-pressure conditions[1]. In this compound, V–V dimerization occurs at approximately 525 K and induces a structural phase transition from the rhombohedral to the triclinic phase. The V–V dimers form a ladder-like ordered arrangement within the vanadium honeycomb lattice. This dimerization is accompanied by an electronic phase transition, which is attributed to the formation of molecular orbitals between adjacent vanadium ions. More recently, we discovered a liquid-like V–V dimer state in ilmenite-type $CuVO_3$[2], as well as a possible amorphous-like V–V dimer state in high-entropy $(Mg_{0.2}Mn_{0.2}Co_{0.2}Ni_{0.2}Cu_{0.2})VO_3$[3]. In this presentation, we will discuss the details of V–V dimerization phenomena and the unusual behaviors exhibited by these dimers.

References:

1. H. Yamamoto *et. al.*, *J. Am. Chem. Soc.* **144**, 1082 (2022).
2. H. Yamamoto *et. al.*, *ACS Omega* **11,** 14, 22093 (2026).
3. H. Yamamoto *et. al.*, *Inorg. Chem.*, **64**, 17496 (2025).

Prof. Hajime Yamamoto (山本孟), Associate Professor
Institute of Multidisciplinary Research for Advanced Materials
Tohoku University
Email: hajime.yamamoto.a2@tohoku.ac.jp
Research interests/Expertise: (1) High pressure synthesis and experiments, (2) Solid state chemistry and physics, (3) Crystallography, (4) Structural and magnetic phase transitions.

Large-Volume High-Pressure Research Using In-situ Synchrotron X-ray Techniques at GSECARS, Advanced Photon Source

Tony Yu, Young Jay Ryu, Timothy Officer, Qi Chen, Bin Zhao, Vitali Prakapenka, Stella Chariton, Peter Eng, Joanne Stubbs, Mark Rivers, Yanbin Wang

Center for Advanced Radiation Sources, The University of Chicago, Chicago, IL 60637, USA

The development of synchrotron-based large-volume high-pressure techniques for studying Earth, planetary, and other materials under extreme pressure and temperature (PT) conditions has been a continuing focus at the GeoSoilEnviroCARS (GSECARS) beamlines of the Advanced Photon Source (APS). Over the past three decades, these developments have enabled researchers worldwide to conduct coordinated investigations on materials in both solid and liquid states. In this presentation we will show several applications of our state-of-the-art techniques to scientific studies, including: (1) ultrasonic velocity measurements of solids and liquids at high PT conditions; (2) rheological properties of materials at high PT; (3) three-dimensional imaging of composite materials using the high-pressure X-ray tomographic microscope; and (4) structure studies of non-crystalline materials using a Paris-Edinburgh Press coupled with a multi-channel collimator. These techniques provide the high-pressure research community with a comprehensive suite of tools for studying the structure, density, elasticity, and viscosity for Earth and planetary materials under extreme conditions.

References:
1. S.R. Sutton *et al.*, *Phys. Chem. Miner.*, **49**, 32 (2022)
2. T. Yu *et al.*, *C.r., Géosci.*, **351**, 269 (2019)
3. Y. Wang *et al.*, *Phys. Earth Planet. Inter.,* **174**, 270 (2009)

Dr. Tony Yu (余國彥), Beamline Scientist
Center for Advanced Radiation Sources, The University of Chicago
Email: tyu@cars.uchicago.edu
Research interests: (1) High pressure mineral physics; (2) Synchrotron X-ray techniques; (3) Structure and physical properties of amorphous materials

Large-Volume Press–Synchrotron Techniques for In Situ Measurements of Phase Transitions and Elasticity

Jennifer Kung

Department of Earth Sciences, National Cheng Kung University, Tainan, Taiwan

Large-volume presses (LVP) provide a powerful platform for generating simultaneous high-pressure and high-temperature conditions in millimeter-sized samples. Their scientific capability is greatly expanded when they are integrated with synchrotron X-ray diffraction, X-radiographic imaging, and ultrasonic interferometry. This combination enables structural, dimensional, and elastic properties to be determined directly under controlled pressure–temperature conditions, rather than inferred from recovered samples.

The $MgSiO_3$ pyroxene system will be used to illustrate the scientific questions that can be addressed using this approach. $MgSiO_3$ pyroxenes are major rock-forming minerals in the Earth's upper mantle and undergo several pressure- and temperature-induced polymorphic transformations that may influence mantle seismic structure. In the integrated large-volume press setup, synchrotron X-ray diffraction identifies the phase present, monitors structural transformations, and provides pressure reading. X-radiographic imaging determines changes in sample length, while ultrasonic travel-time measurements yield compressional- and shear-wave velocities and, together with density measurements, the elastic moduli.

This approach is particularly valuable for high-pressure phases that cannot be preserved after decompression. Such phases must be synthesized, identified, and measured directly within their stability fields. The $MgSiO_3$ high-pressure clinoenstatite phase provides an example of how the combined LVP–synchrotron method can follow structural and elastic changes continuously during compression, heating, phase transformation, and decompression. In addition, changes in wave velocity can reveal metastable, sluggish, or incipient transformations that may be difficult to recognize from diffraction data alone.

The presentation will emphasize how experimental design and the integration of complementary in situ measurements allow large-volume press studies to resolve phase stability, transformation behavior, and physical-property changes under deep-Earth conditions.

Prof. Jennifer Kung (龔慧貞), Associate Professor
Department of Earth Sciences, National Cheng Kung University
Email: jkung@mail.ncku.edu.tw
Research interests: (1) Crystal chemistry; (2) mineral physics; (3) vibrational spectroscopy; (4) high-pressure experiments

Basic idea to make new high-*P* devices for single crystal/powder × X-ray/neutron diffraction at high/low-*T* conditions

Kazuki Komatsu

Geochemical Research Center, Graduate School of Science, The University of Tokyo

I have developed various high-*P* devices up to date; 1) a liquid nitrogen-flow *PT* controlling system for X-ray diffraction, 2) a similar system for powder neutron diffraction (so-called 'Mito system' [1]), 3) an updated 'hybrid' Mito system housing a 4K cryostat [2], 4) a seat for DAC with the widest opening angle for single-crystal X-ray diffraction[3], 5) a DAC for single-crystal neutron diffraction [4], 6) nano-polycrystalline DAC (NPDAC) for powder neutron diffraction up to 100 GPa [5], 7) Cell assembly for neutron diffraction under high-P and high electric field [6], 8) Piston cylinder apparatus for neutron diffraction made of bulk metallic glass [7], and 9) an external heating system for NPDAC. These are the only successful devices, and many "unsuccessful (means not succeeded *yet*)" devices are behind them. I am going to discuss the ideas and motivations that led to these developments, the technical difficulties encountered during the developments, and practical tips that may be useful for researchers attempting similar high-pressure instrumentation. By sharing not only the successful outcomes but also the failures and trial-and-error behind them, I hope to provide a realistic perspective on experimental device development in high-pressure science.

References:

1. K. Komatsu, M. Moriyama, T. Koizumi, K. Nakayama, H. Kagi, J. Abe, S. Harjo: High. Press. Res., 33, 208 (2013).
2. K. Komatsu: Crystallography Reviews, 28, 224 (2022).
3. K. Komatsu, H. Kagi, T. Yasuzuka, T. Koizumi, R. Iizuka, K. Sugiyama, Y. Yokoyama: Rev. Sci. Instrum., 82, 105107 (2011).
4. K. Yamashita, K. Komatsu, S. Klotz, M.T. Fernández-Díaz, O. Fabelo, T. Irifune, K. Sugiyama, T. Kawamata, H. Kagi: High. Press. Res., 40, 88 (2020).
5. K. Komatsu, S. Klotz, S. Nakano, S. Machida, T. Hattori, A. Sano-Furukawa, K. Yamashita, T. Irifune: High. Press. Res., 40, 184 (2020).
6. R. Yamane, K. Komatsu, H.E. Maynard-Casely, S. Lee, N. Booth, H. Kagi: Phys. Rev. B, 99, 174201 (2019).
7. K. Komatsu, K. Munakata, K. Matsubayashi, Y. Uwatoko, Y. Yokoyama, K. Sugiyama, M. Matsuda: High. Press. Res., 35, 254 (2015).

Prof. Kazuki Komatsu (小松一生), Associate Professor
Geochemical Research Center, Graduate School of Science, The University of Tokyo
Email: kom@eqchem.s.u-tokyo.ac.jp
Research interests/Expertise: (1) High pressure crystallography; (2) Physics and Chemistry of ice; (3) Mineral science.

Neutron diffraction from the big and the small

Christopher J. Ridley

Neutron Scattering Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States of America

The SNAP diffractometer at the Spallation Neutron Source, Oak Ridge National Laboratory, is dedicated to neutron diffraction studies of materials under extreme conditions. The instrument is unique in supporting both an established large-volume Paris–Edinburgh press program and routine access to a diamond-anvil-cell (DAC) program, enabling measurements across a broad range of pressure, temperature, and sample-volume regimes. Together, these capabilities allow neutron diffraction studies across orders of magnitude in sample volume, measuring >1-g while also pushing the lower limits of what can be measured with neutrons into the sub-1-mg regime. This has opened new science opportunities at the instrument, including studies of materials that are traditionally challenging for neutron measurements because of spatial or temporal resolution requirements, limited available sample volume, hydrogen content, neutron absorption, or radioactivity.

In this talk, I will present an overview of SNAP and its high-pressure diffraction program, highlighting recent science enabled by Paris–Edinburgh press. I will then discuss developments in neutron diffraction using DACs, including data reduction and correction strategies, current performance limits, and practical considerations for experiments on small or strongly scattering samples. I will conclude with recent efforts to broaden access to high-pressure neutron diffraction and with an outlook on future developments and challenges for extreme-conditions studies at SNAP.

Dr. Christopher J Ridley, Senior Instrument Scientist
Spallation Neutron Source, Oak Ridge National Laboratory
Email: ridleycj@ornl.gov
Research interests: (1) high pressure neutron diffraction (2) behavior of Li-minerals under extreme conditions (3) hydride formation (4) molecular crystallography

Experimental constraints on the thermal structures in Earth and planetary interiors: global and regional

Wen-Pin Hsieh[1,2]

[1]*Institute of Earth Sciences, Academia Sinica, Nankang, Taipei 11529, Taiwan*
[2]*Department of Geosciences, National Taiwan University, Taipei 10617, Taiwan*

Earth's deep mantle is featured by a number of thermochemically heterogeneous structures, such as large low shear-wave velocity provinces, ultralow velocity zones, subducted slabs, and mantle plumes. These heterogeneities co-exist and dynamically interact with each other over Earth history. Thermal conductivities of these heterogeneous structures hold a key to influence Earth's available energy, geodynamics, and thermochemical and geodynamo evolution, yet remain poorly constrained. Using our recently developed, novel combination of an ultrafast optical spectroscopy and laser-heated diamond anvil cells, we have precisely measured the thermal conductivity of important lower mantle minerals with variable representative chemical compositions.[1-3] This allowed us to model the thermal conductivity profiles for pyrolytic lower mantle and iron-rich oxides or melts for the seismic ultralow velocity zones above the core-mantle boundary. I will discuss their effects on the thermochemical evolution at the lowermost mantle and core along with the geodynamo evolution.

References:

1. Wen-Pin Hsieh*, Frédéric Deschamps, Yi-Chi Tsao, Allison Pease, Susannah M. Dorfman, Hannah Bausch, and Fei Wang, "Spin transition in magnesiowüstite and ultralow thermal conduction in ultralow velocity zones," *Nat. Commun.*, **16**, 10431 (2025).
2. Wen-Pin Hsieh*, Yi-Ting Chiang†, Frédéric Deschamps, Chao-Chih Chen†, Jen-Wei Chang†, Daijo Ikuta, and Eiji Ohtani, "Moderate thermal conductivity of Fe-Ni-Si alloy at Earth's core conditions: implications for core thermal evolution and geodynamo," *Geophys. Res. Lett.*, **52**, e2025GL117576 (2025).
3. Wen-Pin Hsieh*, Frédéric Deschamps*, Yi-Chi Tsao†, Takashi Yoshino, and Jung-Fu Lin, "A thermally conductive Martian core with implications for its dynamo cessation," *Sci. Adv.*, **10**, eadk1087 (2024).

Dr. Wen-Pin Hsieh (謝文斌), Professor and Research Fellow
Institute of Earth Sciences, Academia Sinica
Email: wphsieh@earth.sinica.edu.tw
Research interests/Expertise: Thermal, electrical, and elastic properties of materials in Earth and planetary interiors.

Integrated DAC Capabilities at GSECARS for Structural, Vibrational, and Elastic Studies under HP-HT Conditions

Young-Jay Ryu, Vitali Prakapenka, Stella Chariton, Dongzhou Zhang, Tony Yu, and Yanbin Wang

The University of Chicago, Center for Advanced Radiation Sources, Chicago, IL 60637, USA.

The GSECARS diamond anvil cell (DAC) program is being expanded to take full advantage of the enhanced high-flux X-ray beam delivered after the APS upgrade. Recent developments across 13-ID-D, 13-BM-C, and 13-BM-D focus on improving spatial resolution, experimental stability, pressure-temperature control, and multimodal measurements under extreme conditions. At 13-ID-D, new long-working-distance elliptical Si double K-B mirrors, a vibration-stable granite support system, and an upgraded laser-heating optical layout provide the mechanical and optical stability required for high-spatial-resolution laser-heated DAC experiments. At 13-BM-C, single-crystal X-ray diffraction continues to support crystallographic studies of materials under pressure. At 13-BM-D, externally and resistively heated DAC capabilities are being developed for controlled high-pressure and high-temperature experiments combined with in situ X-ray diffraction, Raman spectroscopy, and Brillouin spectroscopy. A newly developed RHDAC enclosure is designed to improve thermal stability, experimental reliability, sample accessibility, and compatibility with synchrotron X-ray and optical spectroscopy measurements.

This presentation will focus on recent GSECARS DAC beamline capabilities, selected beamline experimental examples[1, 2, 3], and the development of a RHDAC enclosure at 13-BM-D. In addition, representative examples of integrated DAC capabilities will demonstrate how combined X-ray scattering, Raman spectroscopy, and Brillouin spectroscopy can constrain structural, vibrational, and elastic responses of materials under extreme conditions. These efforts further expand the scope of the GSECARS DAC program for integrated HP-HT research across Earth and planetary science, glass and melt science, functional materials, and high-energy-density materials (HEDMs).

References:
1. H. W. Horn *et al.*, *Nat.,* **646**, (2025)
2. W. Y. Zhou *et al.*, *Sci.,* **390**, 6776 (2025)
3. M. Berrada *et al.*, *Innov. Geosci*., **3**, 3 (2025)

Dr. Young Jay Ryu (柳榮濟), Beamline Scientist
The University of Chicago, Center for Advanced Radiation Sources
Email: ryu@cars.uchicago.edu
Research interests: (1) High-Pressure and Temperature Silicate Glass/Melt; (2) High-Energy-Density Materials; (3) Materials Science and Physical Chemistry

Strain-induced new superconducting phase in crystal-GeTe

Min-Nan Ou,[1,4*] Cheng-Yen Liu,[1] Ya-Hsin Pai,[1] Tsu-Lien Hung,[3] Ranganayakulu K. Vankayala,[1] Dong-Zhou Zhang,[5] Yi-Jia Tsai,[1,2] Chih-Ming Lin,[2] Yang-Yuan Chen[6]

[1]*Institute of Physics, Academia Sinica, Taipei 115201, Taiwan*
[2]*Department of Physics, National Tsing Hua University, Hsinchu 300, Taiwan*
[3]*Core Facility Center, National Cheng Kung University, Tainan 701401, Taiwan*
[4]*Research Center for Critical Issues, Academia Sinica, Tainan 711010, Taiwan*
[5]*GeoSoilEnviroCARS, Argonne National Laboratory, Argonne, Illinois 60439, USA*
[6]*Department of Applied Informatics, Fo Guang University, Yilan County 262307, Taiwan*

Germanium telluride (GeTe) is a multifunctional material with both thermoelectric and phase-change applications. It exhibits intrinsic semiconducting behavior and becomes superconducting with a transition temperature (T_C) of ~0.3 K under ambient pressure. However, the crystal structure and superconducting properties of GeTe under high pressure remain unclear. In this work, we systematically investigate the pressure-dependent transport properties and structural evolution of GeTe using a diamond anvil cell (DAC). Superconductivity emerges at an initial pressure of 6.3 GPa with a T_C of ~3 K, which further increases to ~4.35 K at 10.9 GPa. The suppression of T_C under an applied magnetic field further confirms the superconducting nature of GeTe. Structural analysis reveals three distinct phases: a low-pressure rhombohedral phase (P < ~6.3 GPa), an intermediate-pressure cubic phase (6.9–17.9 GPa), and a high-pressure orthorhombic phase (P > ~17.9 GPa). Superconductivity is observed exclusively within the pressure range corresponding to the cubic phase. Furthermore, our results suggest that the emergence of superconductivity is strongly correlated with lattice strain. We therefore propose that the observed superconductivity is induced by pressure-driven strain effects rather than being an intrinsic property of the cubic GeTe phase.

References:
1. Y. Wang, *et. al.*, *Journal of Physics: Condensed Matter*, **33**, 355403 (2021)
2. H. Cheng, *et. al.*, *Chemistry of Materials*, **36**, 3764 (2024)

Dr. Min-Nan Ou (歐敏男), Associate Research Scientist
Institute of Physics, Academia Sinica
Email: oumn@gate.sinica.edu.tw
Research interests: (1) Condensed Matter and Low temperature Physics; (2) High-pressure sciences and techniques; (3) Strongly Correlated Electron Systems; (4) Superconductor and magnetic materials; (5) Nano Science; (6) thermoelectric materials

High-Pressure Synthesis and Diamond Anvil Cell Investigation of NIR–SWIR Infrared Emission Transformation

Yi-Ting Tsai,[1] Tadeusz Leśniewski,[2] Natalia Majewska,[2] Mikołaj Kamiński,[2] Justyna Barzowska,[2] En-Pei Liu,[3,4] Wei-Tin Chen,[4,5] Sebastian Mahlik,[2] Mu-Huai Fang[1]

[1]*Research Center for Applied Sciences, Academia Sinica, Taipei 10608, Taiwan*
[2]*Institute of Experimental Physics, Faculty of Mathematics, Physics and Informatics, University of Gdansk, Wita Stwosza 57, 80-308 Gdansk, Poland*
[3]*Department of Physics, National Taiwan University, Taipei 10617, Taiwan*
[4]*Center for Condensed Matter Sciences and the Center of Atomic Initiative for New Materials, National Taiwan University, Taipei 10617, Taiwan*
[5]*Taiwan Consortium of Emergent Crystalline Materials, National Science and Technology Council, Taipei 10622, Taiwan*

Near-infrared (NIR) phosphors have attracted considerable attention for next-generation light-emitting diodes owing to their tunable luminescence properties and broad technological applications; however, precisely tailoring the local coordination environment surrounding activator ions through conventional chemical substitution remains highly challenging. In this work, we propose an engineering strategy using a cubic-anvil-type high-pressure furnace to manipulate the coordination environment of Cr ions in $LiGaO_2$.[1] Notably, two distinct crystal structures were realized within the same chemical composition: α-$LiGaO_2$ provides a purely octahedrally coordinated environment, whereas β-$LiGaO_2$ exhibits a purely tetrahedrally coordinated environment. This unique structural platform enables direct investigation of the coordination-dependent optical properties of Cr ions without changing the chemical compositions, revealing the critical role of local crystal-field symmetry in determining luminescence behavior. In addition, pressure-dependent luminescent properties and Raman spectra were analyzed using a diamond anvil cell, which further helped us understand the differences between the coexistence of temperature and pressure effects and the pressure-only condition. This study provides a versatile platform for exploring coordination-dependent luminescence mechanisms under extreme conditions, which may facilitate the future design and development of advanced NIR phosphors and pressure-responsive optical materials.

References:
1. Y.-T. Tsai *et. al.*, *Chem. Eng. J.* **490**, 151596 (2024).

Dr. Mu-Huai Fang (方牧懷), Assistant Research Fellow
Research Center for Applied Sciences, Academia Sinica
Email: fangmuhuai@gate.sinica.edu.tw
Research interests/Expertise: (1) solid-state electrolytes, (2) nanomaterials, (3) phosphors

Pressure as a Continuous Tuning Knob for Interlayer Electronic Coupling in Two-Dimensional van der Waals Materials

Wei-Ting Hsu

Department of Physics, National Tsing Hua University, Hsinchu 300044, Taiwan

High-pressure techniques have long been used to explore novel material synthesis, structural phase transitions, and matter under extreme conditions. In this talk, I will present a complementary direction: using pressure as a continuous tuning knob to control interlayer electronic coupling in two-dimensional (2D) van der Waals materials. Because the interlayer distance and electronic hybridization in these systems are highly sensitive to external pressure, diamond anvil cell-based optical spectroscopy provides a direct way to track the evolution of excitonic transitions and coupling-related spectral features under compression. Our recent studies show that pressure can exponentially enhance interlayer coupling strength,[1] activate and suppress interlayer coupling, and tune moiré exciton transitions in 2D van der Waals heterostructures. These results demonstrate that pressure is not only a tool for creating extreme conditions, but also an effective tuning parameter for engineering electronic and optical properties in low-dimensional quantum materials.

Reference**:**

1. W.-T. Hsu *et al.*, *Phys. Rev. B* **106**, 125302 (2022).

Funding Acknowledgement**:**

This work was supported by the National Science and Technology Council of Taiwan (Grant No. 112-2112-M-007-036-MY3) and the Yushan Fellow Program from the Ministry of Education of Taiwan (Grant No. MOE-109-YSFMS-0002-001-P1).

Prof. Wei-Ting Hsu (徐瑋廷), Assistant Professor
Department of Physics, National Tsing Hua University
Email: wthsu@phys.nthu.edu.tw
Research interests: (1) Experimental condensed matter physics; (2) Optical spectroscopy and high-pressure techniques; (3) Two-dimensional materials and moiré quantum phenomena.

Pressure Effect on Superconductivity and Strongly Correlated Systems

Chien-Lung Huang

Department of Physics and Center for Quantum Frontiers of Research & Technology (QFort),
National Cheng Kung University

Pressure serves as a highly effective tuning parameter to alter the physical properties of condensed matter systems cleanly, avoiding the chemical disorder typically introduced by chemical doping. In my talk, I will present two example systems-superconductors [1,2] and 4*f* heavy-fermion magnetic systems [3]-to show how the pressure effect induces interesting emergent phenomena. In the former, the superconducting transition temperature can be enhanced or suppressed by pressure, depending on how superconductivity is mediated. In the latter, the magnetic ordering temperature is suppressed to absolute zero, where quantum fluctuations lead to exotic non-Fermi-liquid behavior.

References:
1. Sun *et. al.*, *Nature* **621**, 493 (2023)
2. Cheng *et al.*, *Phys. Rev. Research* **6**, 033253 (2024)
3. Lin *et al.*, unpublished

Prof. Chien-Lung Huang (黃建龍), Associate Professor
Department of Physics, National Cheng Kung University
Email: clh@phys.ncku.edu.tw
Research interests: (1) superconductivity; (2) strongly correlated electronic systems; (3) itinerant magnetism; (4) quantum phase transitions.

Rational Synthesis of Novel Carbon Networks via Crystal Engineering

Haw-Tyng Huang[1,2]

[1]*Department of Materials Science, National Taiwan University*
[2]*Center for Measurement Standards, Industrial Technology Research Institute*

The Nobel Prize laureates in chemistry 2025 have created a family of covalent networks with pores through which gases and other chemicals can flow. These constructions, metal–organic frameworks or covalent organic frameworks, can be used to harvest water from desert air, capture carbon dioxide, store toxic gases or catalyze chemical reactions. Though COFs have robust architecture, they are often porous. In addition, relative to the rich COFs libraries, there are only few examples of “dense” extended carbon-rich networks.

On the other hand, ceramic materials produced by high-pressure solid-state synthesis could offer superior performance in terms of strength, hardness, optical, and thermal properties. For example, diamond is a carbon-based crystalline ceramic network composed of covalent sp^3 carbon bonding. Natural diamond is synthesized at pressures far beyond their thermodynamic stability field, but could maintain long-term, kinetically stable (non-equilibrium) crystal structure at ambient. In my talk, we outlined the design strategies which aim to develop high-performance extended carbon networks via crystal engineering. These materials promise to have not only exceptional mechanical properties, but also optical and thermal properties that may offer significant improvement to lightweight armors materials in military platforms. A series of molecular precursors are reported. These results indicate that extending the ability to design and create covalent connectivity between molecules to making dense ceramics is possible and could lead to a family of new carbon-rich materials.

References:
1. H. T. Huang *et. al.*, *J. Am. Chem. Soc.*, **142**, 42, 17944–17955 (2020); S.C. Rakesh Roshan *et. al.*, *Inorg. Chem.* **63**, 8, 3781-3794 (2024)
2. G.-S. Doucette *et. al.*, *Cell Reports Physical Science*, **1**, 1 (2020)
3. A. Biswas *et. al.*, *J. Phys. Chem. Lett.* **10**, 22, 7164-7171 (2019); M. D. Ward *et. al.*, J. Phys. Chem. C **123**, 18, 11369-11377 (2019)

Prof. Haw-Tyng Huang (黃晧庭), Assistant Professor
Department of Materials Science, National Taiwan University
Email: hawtynghuang@ntu.edu.tw
Research interests/Expertise: (1) High pressure sciences and techniques; (2) Crystal engineering; (3) Pressure-induced polymerization; (4) Low-dose electron microscopy.

The status of TPS 15A, micro-crystal X-ray Diffraction Beamline

Lai-Chin Wu

National Synchrotron Radiation Research Center

TPS 15A is a dedicated single-crystal X-ray diffraction beamline at the Taiwan Photon Source (TPS), developed to support advanced chemical crystallography and experiments under non-ambient conditions [1]. The beamline utilizes a tapered cryogenic undulator (CUT18) as the X-ray source, providing high-brilliance synchrotron radiation over an energy range of 9 – 35 keV. Beam monochromatization is achieved using a dual-mode optical system consisting of a Double Crystal Monochromator (DCM) for monochromatic X-ray operation and a Double Multilayer Monochromator (DMM) capable of generating pink beams with selectable bandwidths of 3% or 5%. This flexible design enables optimization of beam properties for a wide variety of experimental requirements. For beam focusing, TPS 15A incorporates three X-ray mirrors: a focusing mirror (FM) together with vertical (VFM) and horizontal (HFM) Kirkpatrick–Baez (KB) mirrors. The FM delivers a focused beam to experimental station 15A1 with a tunable beam size ranging from 50 × 50 μm^2 to 200 × 200 μm^2. At station 15A2, the KB mirror pair further focuses the beam to approximately 10 × 10 μm^2 at the sample position, enabling high-resolution X-ray diffraction measurements from microcrystals.

End-station 15A1 has been open to users since the 2024-2 operation cycle. Since then, multiple user groups have successfully performed diffraction experiments on challenging crystalline samples, including microcrystals smaller than 20 µm, obtaining high-quality diffraction data. In this presentation, we will showcase the beamline design, capability and diffraction data collected from several widely studied standard compounds, including Ylide, Cytidine, Ruby, and N,N′-Bis(salicylidene)ethylenediamino-nickel(II) (Ni-salen). These results demonstrate the beamline’s capabilities for both routine crystallographic measurements and advanced structural investigations.

References:
1. TPS 15A website: https://tpsbl.nsrrc.org.tw/bd_page.aspx?lang=en&pid=1066&port=15A

Dr. Lai-Chin Wu (吳來錦), Assistant Research Scientist
National Synchrotron Radiation Research Center
Email: wu.lc@nsrrc.org.tw
Research interests (1) Charge Density Analysis (2) High Pressure Crystallography (3) Photo-Crystallography

Non-ambient single crystal X-ray Diffraction beamline at TPS

Shih-Hung Chang, and Jey-Jau Lee

National Synchrotron Radiation Research Center, Hsinchu, Taiwan,R.O.C.

A dedicated small-molecule non-ambient single-crystal X-ray diffraction beamline (SCXRD) at Taiwan Photon Source (TPS) is about to start the commission work. The Cryogenic Tapered Undulator CUT18 are used for X-ray source to generate high brilliance X-ray. The energy of this beamline is tunable within 4.8-35 keV. Both Monochromatic and pink beam modes will be available at this beamline. The monochromatic beam mode will be selected by a high resolution “Double Crystal Monochromator” (DCM) and the pink beam mode will be achieved by Pd/B4C and W/Si (DMM) multilayers (with bandwidth ~ 3-5 % relatively). A Kirkpatrick-Baez (KB) mirror will be used to focus the beam size down to few microns in diameter at sample position.

This beamline is designed for advanced and non-ambient crystallographic requests. Techniques used at this beamline will include (1) Extreme condition that included low temperature high pressure structural studies and also could be included Laue method. (2) Photo-induced excited state structural studies (3) Time-resolved dynamic structural studies with ~100-50 pico-second time resolution via Laue diffraction technique. Those techniques of this beamline will be able to cover physics, chemistry, material and geoscience.

References:

1. T. Graber, S. Anderson*, H. Brewer, Y.-S. Chen, H. S. Cho, N. Dashdorj, R. W. Henning, I. osheleva, G. Macha, M. Meron, R. Pahl, Z. Ren, S. Ruan, F. Schotte, V. S. rajer, P. J. Viccaro, F. Westferro, P. Anfinrud and K. Moffat, *J. Synchrotron Rad.* **18**, 658–67 (2011).
2. Jui-Che Huang, Hideo Kitamura, Cheng-Ying Kuo, Chin-Kang Yang, Cheng-Hsing Chang, Yung-Teng Yu, Yu-Yung Lin, and Ching-Shiang Hwang, *AIP Conference Proceedings*, **1741**, 020016 (2016).

Dr. Jey-Jau Lee (李之釗), Assistant Research Scientist

National Synchrotron Radiation Research Center

Email: jjlee@nsrrc.org.tw

Research interests: Extreme condition with diamond anvil cell

Structural analysis of single crystals under high pressure

Tsu Lien Hung,[1] Kuei-Fang Hsu,[2] Jennifer Kung[3]

[1]*Core Facility Center, National Cheng Kung University, Tainan, Taiwan*
[2]*Department of Chemistry, National Cheng Kung University, Tainan, Taiwan*
[3]*Department of Earth Science, National Cheng Kung University, Tainan, Taiwan*

Investigating crystal structures under extreme conditions is crucial for advancing materials science. Here, we developed an in-house high pressure single-crystal X-ray diffraction setup featuring a 120° opening angle diamond anvil cell at National Cheng Kung University to enhance high-pressure data collection. Measurements were conducted on a Bruker D8 Venture diffractometer with a focused Mo source (110 µm), analyzing 50–70 μm^2 crystals inside a 150 µm gasket hole. A 4:1 methanol–ethanol mixture maintained hydrostatic conditions up to 10 GPa, and pressure was monitored via ruby fluorescence gauge. This system enables precise determination of lattice parameters, phase transitions, and atomic positions. Using this approach, our high-pressure investigations successfully observed the pressure-induced structural transition of spodumene $LiAlSi_2O_6$ from the *C2/c* to the $P2_1/c$ space group, in excellent agreement with previous literature[1].

References:

1. T. Arlt and R. J. Angel, *Phys. Chem Minerals*, **27**, 719-731 (2000)

Dr. Tsu Lien Hung (洪慈蓮), Post-doctoral Fellow
Core Facility Center, National Cheng Kung University
z11205048@ncku.edu.tw
Research interests/Expertise: (1) High pressure science and techniques; (2) Crystallography; (3) Superconductor

APEX6 – User-Friendly and Robust Solutions for Single-Crystal X-ray Diffraction, Including High-Pressure Applications

Ya-Ching Yang

Bruker AXS Division, Bruker Taiwan.

Single-crystal X-ray diffraction (SC-XRD) remains a key technique for precise structure determination. While data collection has become increasingly efficient, the analysis of complex datasets—such as twinned crystals, agglomerates, or non-ideal samples—still requires careful user intervention.

APEX6[1] provides a user-friendly yet powerful environment that supports both routine and challenging crystallographic workflows. Tools such as the Final CIF module simplify the generation of publication-ready results, while AI-assisted crystal centering improves alignment efficiency and reproducibility. For complex cases, the Domain Auto Finder (DAFi)[2] and HKLF5 workflow enable reliable treatment of twinned and multi-domain structures.

APEX6 also supports high-pressure SC-XRD experiments,[3] particularly for diamond anvil cell (DAC) measurements. Reliable indexing and integration are maintained despite limited reciprocal space coverage and increased background. Flexible tools allow effective handling of overlapping reflections and complex diffraction patterns.

By combining ease of use with robust analytical capabilities, APEX6 enables reliable structure determination from routine measurements to demanding high-pressure experiments.

References:

1. Bruker (2024). APEX6. Program for data collection and analysis of single-crystal X-ray diffraction data. Bruker AXS Inc., Madison, Wisconsin, USA.
2. Aslandukov, A. et al. J. Appl. Cryst., 55, 1383–1391(2022)
3. Binns, J., Kamenev, K. V., McIntyre, G. J., Moggach, S. A., & Parsons, S. *IUCrJ*, **3**, 168–179(2016)

Dr. Ya-Ching Yang (楊雅晴), Application Scientist
Bruker Taiwan
Email: ya-ching.yang@bruker.com
Expertise: (1) Chemistry Crystallography SCD; (2) Powder X-ray Diffraction; (3) Polycrystalline Thin Film diffraction.

High-Pressure Crystallography on Concurrent Home Laboratory Instruments

Christian Göb,[1]* Jian-Hong Liao,[2] Fraser White,[3] Jakub Wojciechowski,[3] Pierre LeMagueres,[4] Joseph Ferrara,[4] Mathias Meyer,[5] Marcin Grzesczyk[5]

[1] Rigaku Asia Pacific Pte. Ltd., Singapore; [2] Rigaku Technology Taiwan Co. Ltd., Zhubei City, Taiwan (R.O.C.);

[3] Rigaku Europe SE, Neu-Isenburg, Germany; [4] Rigaku Americas, The Woodlands, United States;

[5] Rigaku Oxford Diffraction, Wroclaw, Poland.

Advances in laboratory diffraction instrumentation have expanded structural characterization well beyond routine single-crystal X-ray diffraction. Modern platforms integrating high-brilliance microfocus X-ray sources, hybrid photon-counting detectors, dual-wavelength capability, and intelligent automation now support a broad range of crystallographic experiments on increasingly challenging samples, including measurement of crystals under high pressure.

This presentation highlights the versatility demands on concurrent instrumentation. The advantages of dual-wavelength operation, high-flux sources, zero background detectors with highest dynamic ranges, automated workflows for optimal data quality for high-pressure experiments and experimental efficiency will be discussed.

Figure 1. $Na_4O_{17}U$ under high pressure: Hardware and software in Synergy.

Dr. Christian Göb, Regional BD Manager for Single Crystal Diffraction

Rigaku Asia Pacific Pte. Ltd., Singapore

Email: christian.goeb@rigaku.com

Research interests: Single crystal crystallography

Diamond Sponsor

康達儀器有限公司

Tungsten Carbide Sponsor

日商理學科技股份有限公司
台灣分公司

益弘儀器股份有限公司

布魯克生命科學
股份有限公司

Sponsor

台灣思百吉股份有限公司
Malvern Panalytical

勝綻科技股份有限公司

Quantum Design

Pressure Cell (Transport)

DynaCool (D420) / PPMS (P420) / VersaLab (V420)

Often a sample's electrical transport properties evolve under the application of substantial hydrostatic pressure. The Transport Pressure Cell Option for the PPMS® is manufactured by ElectroLab, a leading Japanese supplier of pressure cells. It enables up to two 4-probe measurements (typically for the sample and a manometer) of electrical transport at pressures as high as 2.7 GPa. Samples are mounted to pre-made sets of electrical leads with integrated feedthroughs for pressurization in an oil media using a bench-top press to apply load.

Key Features:

- Complete kit includes required tools and materials for mounting samples, applying pressure to the cell, and measuring pressure
- Includes manometer materials of tin and lead, whose superconducting transition temperatures can be accurately measured via integrated thermometry which can be used to infer actual cell pressure
- Cell can be installed in the PPMS using standard puck insertion/extraction tool
- Data can be collected with any PPMS-compatible QD transport option
- 10 total sample leads (5 twisted pairs) included with each feedthrough set

Press specifications

Model	CDM-5PAS (5 ton)	CDM-10PAS (10 ton)
Maximum pressure	70 MPa	70 MPa
Bore area	7.16 cm²	14.52 cm²
Mass	10 kg	25 kg

Optional – digital pressure gauge

Pressure Cell (Transport) Specifications

Pressure [P]

Maximum Sample Pressure:	2.7 GPa
Maximum Applied Load:	3.0 GPa
Sample Space Parameters	
Diameter:	4 mm
Length:	6 mm
Operational Range	1.8 to 400 K; 0 to 16 T

Specifications are subject to change without notice.

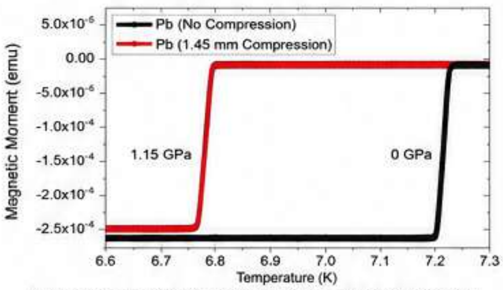
High Pressure Cell for Electric Transport Measurements

High Pressure Cell

Often a sample's magnetic properties evolve under the application of substantial hydrostatic pressure. The pressure cell option manufactured by HMD, a leading Japanese supplier of pressure cells, offers a simplified design that requires neither copper sealing rings or a hydraulic press to achieve the maximum available pressure of 1.3 GPa. BeCu construction affords a minimized, uniform magnetic background.

Key Features:

- Complete kit includes required tools and materials for mounting samples, applying pressure to the cell, and measuring pressure
- Included manometer materials are tin and lead whose superconducting transition temperatures can be used to infer actual cell pressure
- BeCu construction provides minimal background signal and is also compatible with AC susceptibility measurements at suitably low frequencies



Temperature-dependent magnetization (H = 2 Oe) of elemental lead (Pb) depicting the suppression of the superconducting transition with applied pressure. For a given compression length of the cell the transition temperature can be measured and the pressure calculated using an equation of state.

Pressure Cell Kit

High Pressure Cell

High Pressure Cell Specifications

Pressure	
Maximum Sample Pressure:	1.3 GPa
Sample Space Parameters	
Diameter:	1.7 mm, 2.2 mm
Length:	7 mm
Magnetic Moment [m]	
Background Signal:	$4 \cdot 10^{-7}$ emu/T
Operational Range	1.8 to 400 K; 0 to 7 T

Specifications are subject to change without notice.

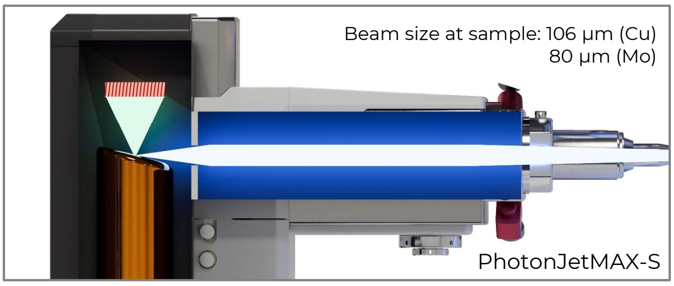
Single Crystal Products

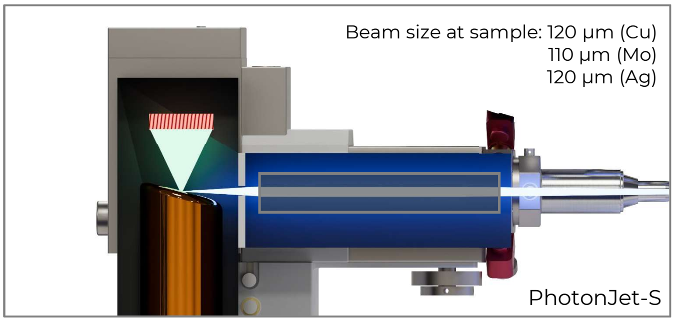
Single Crystal Diffraction

XtaLAB Synergy S

Fast, accurate, intelligent.

Structural scientists have made this our most popular diffractometer. XtaLAB Synergy-S supports our highest performance microfocus sealed tubes on a flexible platform for more demanding techniques and experiments like high-pressure crystallography. With a choice between PhotonJet-S and PhotonJetMAX-S you can tune intensity and beam size to your demands. The XtaLAB Synergy-S diffractometer is the perfect crystallography system when low running costs without compromises to data quality are your primary concern.





Improved photon capture powers the PhotonJetMAX-S

Proprietary optics from Rigaku gather more photons from the X-ray tube and focus them on the sample – ideal when working with small gasket sizes and tiny crystals. Smaller beams are optimized for today's more challenging samples.

Copper: Up to 2.6x the diffracted intensity*
(average based on 6 experiments)

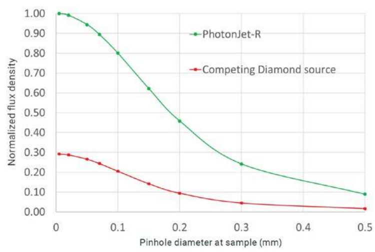
Molybdenum: Up to 2.5x the diffracted intensity*
(average based on 4 experiments)

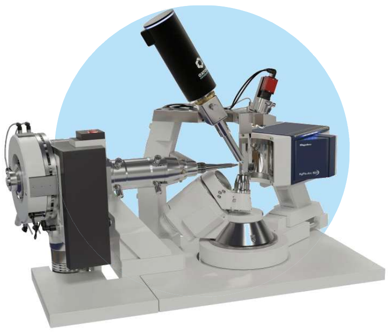
* vs PhotonJet-S

XtaLAB Synergy DW

Intensely versatile.

Be versatile. One source with two high-flux wavelengths is the foundation of the revolutionary XtaLAB Synergy-DW single crystal X-ray diffractometer. It combines the increased flux of a rotating anode X-ray source with the flexibility of two different wavelengths, making it ideal for laboratories exploring a wide range of research interests.





With any 2-fold combination of Cu, Mo or Ag radiation it is the perfect diffractometer for a core facility where various typed of samples, e.g. small molecules, metal-organic frameworks, protein crystallography or specialized techniques like high-pressure crystallography or pair-distribution analysis are practiced and high throughput is a key concern. Now available with optional Intelligent Optics Module (iOM) for automated source alignment.

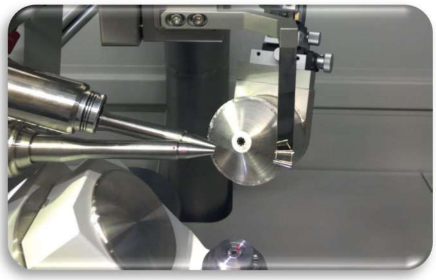
Single Crystal Products

Single Crystal Diffraction

High-Pressure Kit

Accommodating the vast majority of commercially available and custom high-pressure cells, the high-pressure kit creates a sample space with an 7 cm diameter. It is easy to switch between high pressure and standard mode and, with powerful high-pressure software tools to aid with data analysis and processing, high-pressure experiments have never been easier. The design of the goniometer allows for integration of third-party ruby fluorescence systems for in-situ measurements of pressure.

Selected third-party temperature attachments



CrysAlis^{Pro} is ready for the next generation Cryostream 1000 and N-Helix from Oxford Cryosystems. With full support for control over ethernet, you can automate variable temperature experiments, anneal samples or simply shutdown your Cryostream at the end of your experiment to conserve LN_2. When you want to go to high temperatures for materials research or similar techniques, XtaLAB Synergy diffractometers can be ordered with compatibility to devices like the XDS Oxford Gas Blower. The Gas Blower offers temperatures up to 1000°C.

Hybrid photon Counting detectors for best data quality

HyPix-Bantam

HyPix-6000 HE

HyPix-Arc 100°

HyPix-Arc 150°

Why choose HyPix detectors?

Direct X-ray detection and true photon counting

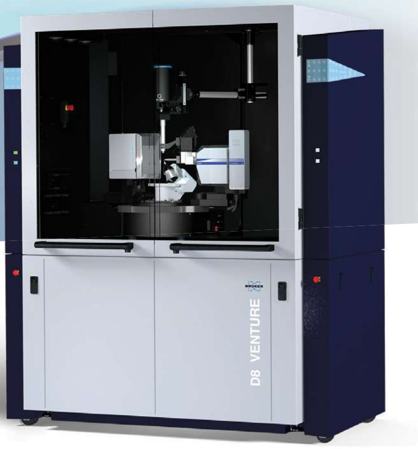
- No detector noise
- Huge dynamic range
- Zero readout time shutterless operation
- No dead time
- Selectively measure photons by energy
- Good spatial resolution
- Sensitive to all wavelengths
- High coverage

From Film to HPCs:
Why Detector Technology Matters

Webinar

Perspective: How detectors make a difference

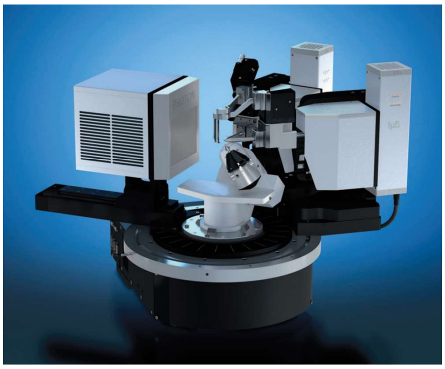
Interview



Bruker第三代D8 VENTURE

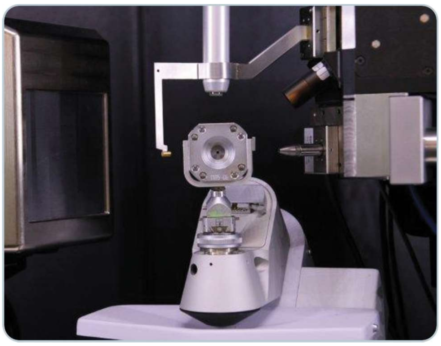
In-house單晶 / 粉末高壓 XRD 實驗全方位頂級平台

第三代 D8 VENTURE: 賦予單晶繞射實驗無限可能性

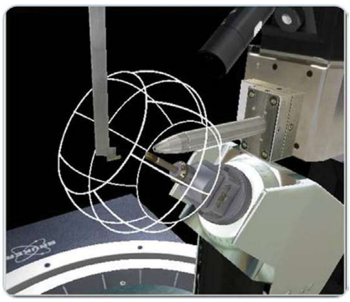


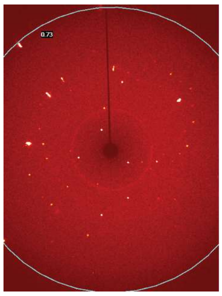
- **IµS Diamond 鉬 / 銀微焦斑光源**
  - 媲美旋轉靶等級的超高光通量
  - 免維護設計, 長期穩定運行
- **Metal Jet In 液態靶 X 射線光源:**
  - 實驗室內光強最高、波長最短之 X 射線源
- **PHOTON IV混合光子技術偵測器**
  - 採用 XFEL CPAD 專業偵測器技術
  - 針對鉬 / 銀 / 銅靶 X 射線具備業界頂尖偵測靈敏度
- **APEX 6高效能單晶繞射數據處理核心，輸出高精準度繞射數據**

機台具備彈性寬敞的樣品操作空間，
相容各式 DAC 高壓樣品台



搭配客製化準直儀與Beamstop，
晶片軟體自動辨識元件, 可快速拆裝;
內建 3D 光束路徑演算規劃，
完善防撞保護機制, 實驗操作更安全。





Bruker Taiwan Co. Ltd.

Taipei office
19F-5, No.93, Sec. 1, Xintai 5th Rd., Xizhi Dist., New Taipei City 22175, Taiwan
Tel.02-86981212/Fax.02-86981010

Hsin Chu office
3F - 3, No.6, Taiyuan 1st St.,
Zhubei City, Hsinchu County30288,Taiwan
Tel.03-5601212/Fax.03-5601060

For more information please visit www.bruker.com

Innovation with Integrity

Application of X-ray absorption spectroscopy with a laboratory X-ray powder diffractometer

Milen Gateshki,* Charalampos Zarkadas and Detlef Beckers

Malvern Panalytical BV, Lelyweg 1, 7602 EA, Almelo, The Netherlands.

A novel method and experimental configuration are proposed, which allow the collection of high-quality X-ray absorption spectroscopy (XAS) data in transmission mode on a standard laboratory diffractometer. This configuration makes use of components that have been developed for application in modern laboratory diffractometers, such as X-ray tubes with enhanced stability, accurate goniometers and position-sensitive photon-counting detectors with improved energy resolution. Such an approach may extend the application of XAS in materials research, particularly for users of diffraction methods.

References:

1. M. Gateshki *et. al.*, *J. Appl. Cryst.* **59,** 451-461 (2026).

Dr. Plex Lee (李秉中), Application Team Leader
Malvern Panalytical, Taiwan
E-mail: plex.lee@malvernpanalytical.com
Research interests: (1) X-ray diffraction (2) Semiconductor manufacture (3) Thermoelectric materials (4) Nanomaterials

HIGH TEMP & HIGH PRESSURE MATERIALS SOLUTIONS

高溫高壓材料研發與分析整合方案

勝博國際

前瞻材料製備 ・ 元素分析 ・ 高溫前處理 ・ 超音波精密清洗

針對航太、半導體及先進能源等極端環境材料，提供從研磨粉碎、高溫燒結至微量元素定量與前處理的全方位高精度實驗室設備支援。

冷卻混合研磨機

MM 500 control

高能研磨 ・ 溫控材料粉碎

- 專為高溫高壓敏感材料設計之極限研磨
- 專利液氮 / 流體冷卻系統，防止材料熱降解
- 高頻率振動，快速達奈米級粉碎效果

碳硫分析儀

ELEMENTRAC CS-d

高頻感應與高溫管爐雙爐整合

- 精準測定耐高溫合金與陶瓷中之碳/硫含量
- 雙爐一體設計：涵蓋無機金屬與有機樣品
- 非分散紅外線 (NDIR) 高靈敏度檢測

高溫真空管狀爐系統

High-Temp Tube Furnace

高溫熱處理 ・ 控制氣氛燒結

- 支援極端高溫環境，具備高精度溫控
- 可搭配高真空與特殊氣氛環境
- 多區獨立控溫，優化燒結均勻度

多功能超音波清洗機

Elmasonic Select

精密前處理 ・ 高效脫氣脫脂

- 多種超音波模式 (Sweep / Degas / Dynamic)
- 智慧設定，提供樣品精準清潔效果
- 耐腐蝕槽體設計，延長設備使用壽命

網頁資訊：http://www.sunpro.com.tw

了解更詳盡的產品介紹或樣品測試，請洽：

台北 - 勝綻科技
電話：02-8791-8971
E-Mail：sunbloom@sun-bloom.com.tw

台中 - 勝瑋科技
電話：04-2298-0365
E-Mail：sunwise@sun-wise.com.tw

高雄 - 勝騏科技
電話：07-338-5550
E-Mail：suncheer@sun-cheer.com.tw

Organizer

國立台灣大學 凝態科學研究中心
高壓先端材料研究室

極端條件實驗室

Co-organizer

國立台灣大學 新穎材料原子級科學研究中心

物理研究推動中心

台灣物理學會

中華民國地質學會 高壓科學研究會

High-Pressure Sciences Research Association (HPSciReA)
subdivision of GST, Taiwan

為推動高壓科學研究發展，落實跨學門交流與合作，**高壓科學研究會**期望作為會員和跨學門人士合作的平台，研商高壓相關科學研究議題、推廣新知，並定期舉辦相關研習活動，整合與發展台灣高壓科學之研究能量。**高壓科學研究會**會員來自於國內外不同單位（如中研院、大專院校、科學博物館、同步輻射研究中心等），具不同研究興趣與專長（高壓科學、岩礦、斷層力學、晶體學、凝態物理、超導體、光學、磁性材料、奈米材料、寶石鑑定等），歡迎有志一同的夥伴們加入！

高壓科學研究會發展方向為：

一、 培養高壓研究人才
二、 整合研究設施及資源交流
三、 建立核心研究平台
四、 提供資訊交流平台
五、 規劃整合型研究計劃

Website　　Line Group

第 88 屆高壓科學研究會委員 暨 2026 高壓科學工作坊議程委員

召集人： 陳威廷 國立臺灣大學 凝態科學研究中心

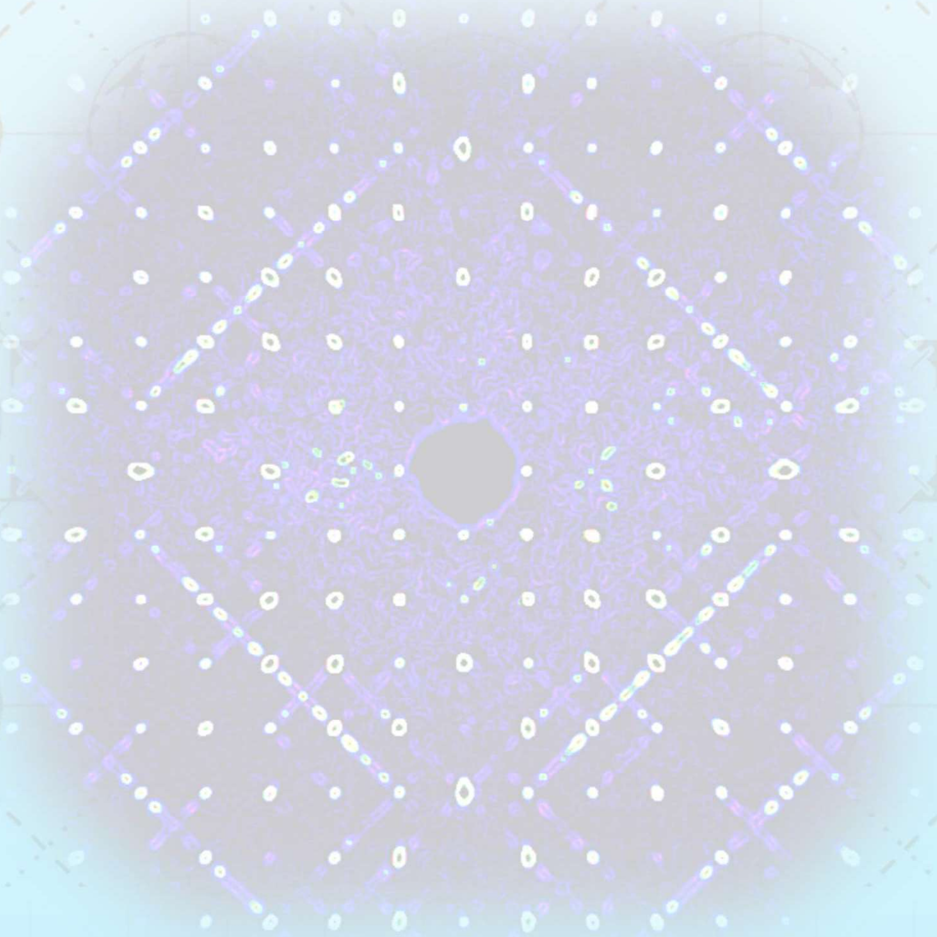
委　員： 謝文斌 中央研究院 地球科學研究所
洪慈蓮 國立成功大學 核心設施中心
余國彥 美國芝加哥大學 先進光子源
吳來錦 國家同步輻射研究中心
徐瑋廷 國立清華大學 物理學系
簡祐祥 捷斯奧集團 台灣阿里山鑽石公司
郭力維 國立中央大學 地球科學系
李佩倫 國立嘉義大學 數位學習設計與管理學系

Title______________________ Date________________

Title______________________ Date________________

Title______________________ Date________________

Title______________________ Date________________



高壓科學研究會