NextGEM

2026

International Symposium on *Next-Generation Energy Materials and Devices*

28th – 30th September

GOLD COAST, AUSTRALIA





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WELCOME

Welcome message from Chair and Co-Chairs

It is our great pleasure to warmly welcome all participants to the International Symposium on Next-Generation Energy Materials and Devices (NextGEM26), to be held on the Gold Coast, Australia, from 28–30 September 2026.

The growing global concern about climate change, together with increasing energy demand, has made the development of sustainable and clean energy technologies one of the greatest challenges facing humanity. Addressing these challenges requires innovative energy materials and technologies for efficient energy generation, conversion and storage, as well as for low-energy-consumption systems.

NextGEM26 places a strong emphasis on bringing together world-leading scientists, active researchers at different career stages, HDR students and industry partners working in sustainable energy materials and technologies. The symposium features a diverse and multidisciplinary program designed to showcase new and exciting advances in next-generation energy materials and devices, facilitate the exchange of ideas, and foster new research collaborations.

There are nearly 300 delegates from 12 countries and regions including a long list of outstanding plenary, keynote and invited speakers who will share their latest research and insights. We hope the symposium will provide an inspiring environment for participants to learn about emerging energy-focus developments, exchange ideas, interact with colleagues and establish new collaborations.

We greatly appreciate the strong support of all our participants and the generous contributions of our sponsors. We would also like to extend our sincere thanks to all the volunteers who have generously contributed their time and effort to support various aspects of the conference.

We hope you enjoy NextGEM26 and have a productive and memorable time on the Gold Coast.

Welcome to NextGEM26!

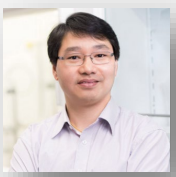
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Dewei CHU, Co-Chair
Ziqi SUN, Co-Chair
John BELL, Honorary Chair



Prof. Hongxia WANG



Prof. Dewei CHU



Prof. Ziqi SUN



Prof. John BELL

ORGANISERS

Organising Committee

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Dr. **Fan Zhang** (Queensland University of Technology)

Symposium Secretaries

Dr. **Jiaye Ye** (Queensland University of Technology)
Dr. **Minh Tam Hoang** (Queensland University of Technology)

SCHEDULE AT A GLANCE

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27/09/2026</th><th>Day1
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<tr><td rowspan="8"></td><td>Opening /
Plenary Session
(8:30 – 10:30)</td><td>Plenary Session /
Panel Discussion session
(8:30 – 10:15)</td><td>Parallel Session (×5)
(9:00 – 10:27)</td></tr>
<tr><td>Morning Tea
(10:30 – 10:50)</td><td>Morning Tea
(10:15 – 10:35)</td><td>Morning Tea
(10:30 – 10:50)</td></tr>
<tr><td>Parallel Session (×5)
(10:50 – 12:00)</td><td>Parallel Session (×5)
(10:40 – 12:25)</td><td>Parallel Session (×5)
(10:50 – 12:30)</td></tr>
<tr><td>Lunch
(12:00 – 13:00)</td><td>Lunch
(12:25 – 13:35)</td><td>Lunch
(12:15 – 13:15)</td></tr>
<tr><td>Plenary Session
(13:00 – 14:10)</td><td>Plenary Session
(13:25 – 15:10)</td><td>Parallel Session (×5)
(13:15 – 15:00)</td></tr>
<tr><td>Parallel Session (×5)
(14:15 – 15:25)</td><td>Afternoon Tea
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(16:00–20:00)</td><td>Afternoon Tea
(15:25 – 15:45)</td><td>Parallel Session (×5)
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(15:20–15:50)</td></tr>
<tr><td rowspan="2">Welcome reception
(18:00–20:00)</td><td>Parallel Session (×5)
(15:45 – 17:30)</td><td>Poster Session
(17:00 – 19:00)</td><td>/</td></tr>
<tr><td>/</td><td>Banquet
(19:00 - 23:00)</td><td>/</td></tr>
</table>

GENERAL INFORMATION

WiFi Access Instruction

To access the complimentary WiFi services during the NextGEM26 conference, use the following to log in.

Network: CrownePlaza-Guest

Password: GoldCoast

Guest Fire Procedure

In Case Of Emergency:

- Remain in the function room.
- Announcements will be made periodically over the in-house P.A system informing you of the situation.
- A staff member will arrive and inform you if there is a need to evacuate. If so, they will evacuate you in an orderly manner to the nearest exits and take you to the **evacuation meeting point located on Beach Parade**.
- **If you see a fire call – CALL 666 from the function room.**

Gala Dinner

Time: 19:00 – 23:00, 29th September 2026 (Tuesday)

Location: The Norfolk Room, Crowne Plaza Surfers Paradise

VENUE FLOOR PLAN

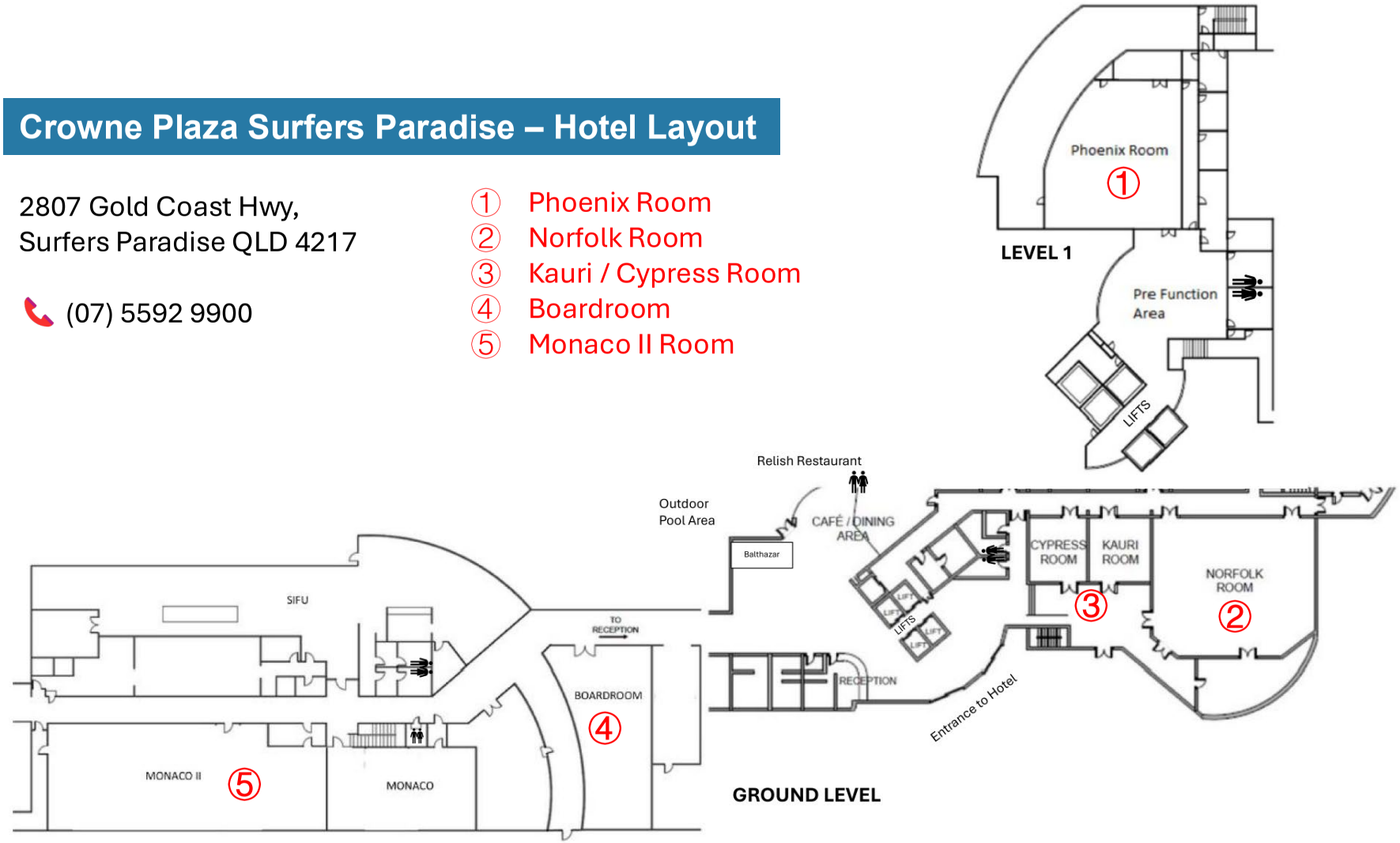
NextGEM26

Crowne Plaza Surfers Paradise – Hotel Layout

2807 Gold Coast Hwy,
Surfers Paradise QLD 4217

(07) 5592 9900

① Phoenix Room
② Norfolk Room
③ Kauri / Cypress Room
④ Boardroom
⑤ Monaco II Room



PLENARY SPEAKERS



Prof. Tsutomu Miyasaka, completed the Graduate School of Engineering at the University of Tokyo in 1981 (PhD in Engineering). After serving as a senior researcher at Fuji Photo Film Co., Ltd., he became a professor at the Graduate School of Engineering at Toin University of Yokohama in 2001. From 2005 to 2010, he was a visiting professor at the Graduate School of Arts and Sciences at the University of Tokyo. In 2004, he founded Peccell Technologies Inc. as CEO. His research specializes in photoelectrochemistry and hybrid photovoltaic cells, especially perovskite solar cells. Awards include Kyoto Prize (2026), NIMS Award (2025), Japan Academy Prize (2024), Rank Prize (2022), Japan Society of Applied Physics Achievement Award (2019), Chemical Society of Japan Award (2017), Clarivate Analytics Citation Laureate (2017), etc.



Dr. Shizhang Qiao is a Chair Professor at Adelaide University, Australia. His research expertise is in nanostructured materials for new energy technologies (electrocatalysis, batteries, etc). He has co-authored more than 630 papers in refereed journals with 167,000 citations and an h-index of 210. Prof Qiao was honoured with ARC Industry Laureate Fellow, Australian Laureate Fellow. He is an elected Fellow of Australian Academy of Science (FAA), Fellow of Australian Academy of Technological Sciences & Engineering (FTSE), and a Clarivate Analytics Highly Cited Researcher in three categories of Chemistry, Materials Science, Environment and Ecology.



ANU **Distinguished Professor Yun Liu** is an internationally recognised leader in materials chemistry and polar functional materials. She completed her PhD at Xi'an Jiaotong University in 1997, held AIST and STA Fellowships in Japan (1998–2001), and joined ANU in 2001, leading its Functional Materials Research Group since 2006. She was awarded the ARC QEII, Future and Australian Laureate Fellowship. She is a Fellow of the Australian Academy of Science, ATSE, AIP and RACI, and currently chairs the Asian Electroceramics Association. Her research investigates the defect and crystal chemistry of solids, linking chemistry, structure and properties to guide the design of functional materials.



Debra Bernhardt is a Fellow of the Australian Academy of Science. She is known for advancing nonequilibrium statistical mechanics and thermodynamics and her research has been recognized through award of an ARC Australian Laureate Fellowship. She examines far-from-equilibrium and confined fluids using theoretical and computational approaches, with applications to a broad range of topics, especially next generation energy storage and conversion.

PLENARY SPEAKERS



Distinguished Professor Guoxiu Wang is the Director of the Centre for Clean Energy Technology at the University of Technology Sydney (UTS). Professor Wang is an expert in materials chemistry, electrochemistry, energy storage and conversion, and battery technologies. Currently, he serves as an Associate Editor for Electrochemical Energy Reviews (Springer-Nature) and an Associate Editor for Energy Storage Materials (Elsevier). His research interests include Li/Na-ion batteries, lithium-air batteries, Li-S batteries, CO_2 conversion, and electrocatalysis for hydrogen production. Professor Wang has published more than 800 refereed journal papers, which have attracted more than 105,000 citations (h-index of 177, Google Scholar). He has been recognised as a highly cited researcher in Materials Science and Chemistry by Web of Science/Clarivate Analytics. Professor Wang is a Fellow of the Australian Academy of Science (FAA) and Fellow of the Australian Academy of Technological Sciences & Engineering (FTSE). Professor Wang is an Australian Research Council (ARC) Industry Laureate Fellow.



Maria Antonietta Loi earned her PhD in physics from the University of Cagliari in 2001. She began her career as a postdoctoral fellow at the Linz Institute for Organic Solar Cells and later worked at the Institute for Nanostructured Materials in Bologna. In 2006, she joined the University of Groningen as an assistant professor and Rosalind Franklin Fellow, where she now serves as a full professor and chairs the Photophysics and OptoElectronics group. With over 300 peer-reviewed publications, she is an expert in photophysics and optoelectronics. Her accolades include ERC Starting (2013) and Advanced (2022) Grants, the Physicaprijs (2018), and fellowships from the APS, KNAW, EURASC, Royal Society of Chemistry, MRS, and Leopoldina. She serves as Editor-in-Chief of Applied Physics Letters.



Alex Jen is the Lee Shau-Kee Chair Professor and Founding Director of the Hong Kong Institute for Clean Energy at the CityUHK. He published more than 1,250 SCI papers with >115,000 citations and an H-index of 175. He also co-invented 73 patents and invention disclosures. He was elected as Academician by the European Academy of Sciences and as Fellow for several prestigious professional societies, including AAAS, MRS, ACS, PMSE, OSA, and SPIE. He was named by the Times Higher Education (THE) in 2018 as a "Top 10 University Researchers in Perovskite Solar Cell Research". In addition, he was recognized by Thomson Reuters as one of the "World's Most Influential Scientific Minds" in 2015 and 2016 and by Clarivate as a "Highly Cited Researcher" in Materials Science from 2014-2025.

PLENARY SPEAKERS



Joanne Etheridge is an Australian Research Council Laureate Fellow in the School of Physics and Astronomy at Monash University. She obtained a degree and PhD in physics from the University of Melbourne and RMIT University, respectively, before appointments at the University of Cambridge in the Department of Materials Science and Metallurgy and Newnham College, including a Rosalind Franklin Research Fellowship and a Royal Society University Research Fellowship. She returned to Melbourne to join Monash University where she established the Monash Centre for Electron Microscopy. She conducts research in the theory and development of new electron scattering methods for determining the atomic and electronic structure of condensed matter. She applies these methods to understand structure-property relationships in functional materials, including materials for controlling light, energy generation and storage. She is a Fellow of the Australian Academy of Science.



Su-Huai Wei is currently a Chair Professor and Dean of School of Physics at the Eastern Institute of Technology (EIT), Ningbo, China. He received his PhD from the College of William and Mary in USA in 1985. After that, he joined the National Renewable Energy Laboratory (NREL) and was a Laboratory Fellow and Manager of the Theoretical Materials Science Group before he joined the Beijing Computational Science Research Center (CSRC) as Head of the Materials and Energy Division in 2015. He moved to EIT in 2024. His research is focused on developing electronic structure theory of semiconductors for optoelectronic and energy related applications. He is a Fellow of both the American Physical Society and the Materials Research Society.



Dr. Shengzhong Liu received his PhD from Northwestern University, USA in 1992. Upon completing his postdoctoral research at Argonne National Laboratory in 1994, he joined Solarex/BP Solar and United Solar Ovonic. In 2012, he joined Shaanxi Normal University and Dalian Institute of Chemical Physics (DICP), Chinese Academy of Sciences. He is now the director of Institute for Advanced Energy Materials, Shaanxi Normal University and Associate Director of Solar Energy Department, Dalian National Laboratory for Clean Energy. Professor Liu's research outcomes in nano and thin film materials, photovoltaic materials and solar cells have been published in leading scientific journals, including Science, Nature, etc and been translated to commercial products. He has an H-index of over 140. He is selected as the top 1% most highly cited author by RSC and Clarivate Analytics.

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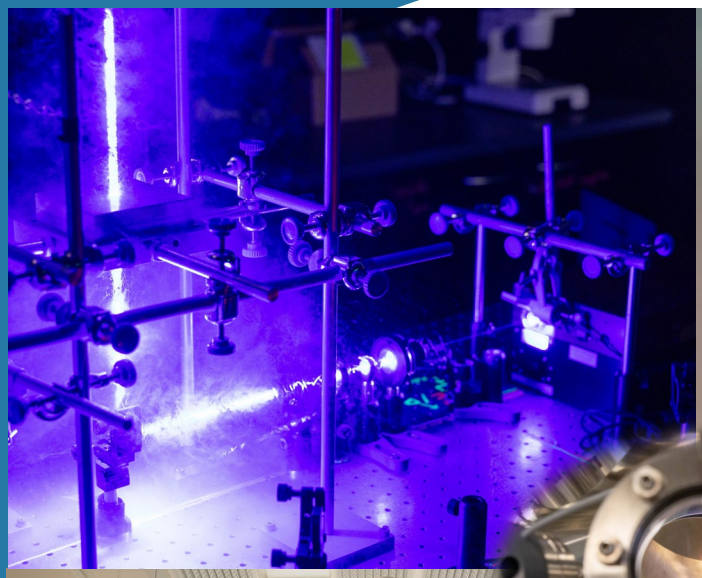
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The QUT Centre for Materials Science (CMS) is a leading interdisciplinary research centre advancing materials discovery through expertise in chemistry, physics, engineering, computational modelling, and advanced characterisation. Guided by its vision to enrich the human experience through materials innovation, CMS undertakes curiosity-driven research that delivers impact across advanced manufacturing, clean technologies, energy storage, healthcare, electronics, and quantum technologies. Supported by world-class infrastructure and facilities that attract high-value national and international collaborations, CMS enables cutting-edge research, capability development, and innovation. Bridging fundamental discovery, interdisciplinary collaboration, and technological advancement, CMS is driving progress in quantum technologies, emerging energy materials, and AI-enabled materials discovery.

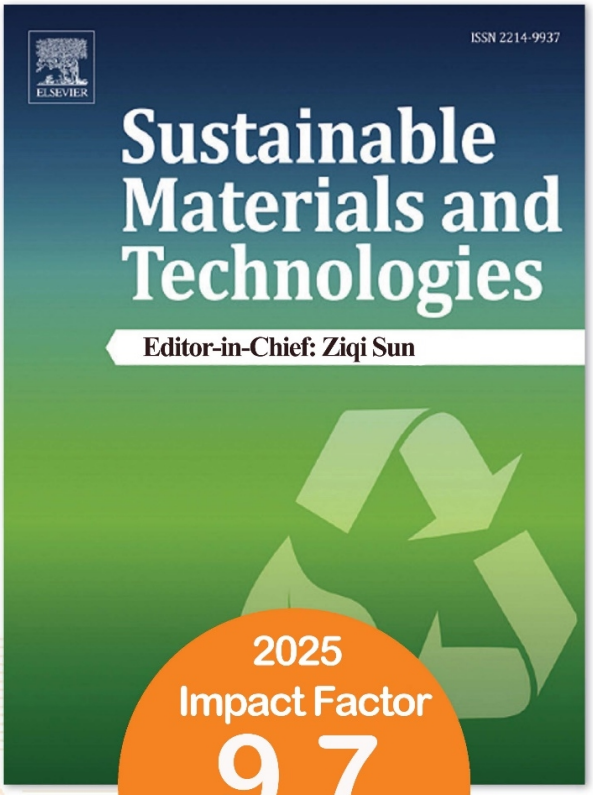
ARC Research Hub in Zero-emission Power Generation for Carbon Neutrality



The ARC Research Hub for Zero-Emission Power Generation for Carbon Neutrality (ZeroPC) brings together researchers and industry partners to accelerate Australia's transition to net-zero emissions. The Hub develops integrated technologies that harvest renewable energy from waste heat and sunlight, store it safely in environmentally friendly batteries, and use this energy to convert CO_2 into valuable fuels and chemicals. Its research encompasses thermoelectric generators, solar cells and solar fuels, proton and lithium-ion batteries, advanced electrocatalysts, and integrated energy systems. By enhancing efficiency, durability, scalability, and manufacturability, ZeroPC aims to accelerate commercialisation, strengthen industry capability, develop a skilled workforce, and support Australia's net-zero target for 2050.

ELSEVIER

SUSTAINABLE MATERIALS AND TECHNOLOGIES



EDITOR-IN-CHIEF



Prof. Ziqi Sun
Queensland University of Technology, Australia

Sustainable Materials and Technologies (SM&T) is an international, **cross-disciplinary** journal, published by Elsevier. SM&T publishes original full-length research articles and reviews in applied or fundamental science of nano-, micro-, meso-, and macro-scale aspects of materials and technologies for sustainable development with special attention to contributions that reduce the knowledge gap between materials and system designs.

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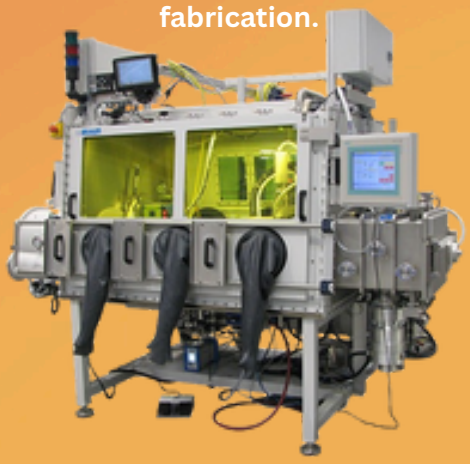
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CiteScore: 29.9

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- **Paper style** review, perspective (mini review), research article, letter
- **Supporting** Open Access publications

JCR Category	Category Rank	Category Quartile
Materials Science, Multidisciplinary	42/472	Q1
Metallurgy & Metallurgical Engineering	1/97	Q1

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Hefei In-situ Technology Co., Ltd., founded in 2019, is a national high-tech enterprise that provides preparation, synthesis, characterization and evaluation instruments, as well as specialized equipment for customers in materials, chemical engineering, catalysis, energy, scientific research and other industries. Headquartered in the Hefei National Comprehensive Science Center, the company has sales and technical support centers in Beijing, Shenzhen and Chengdu, with resident sales personnel across the country.

We have four main product lines: in-situ characterization system solutions (including testing), Joule heating devices, catalyst evaluation setups and battery preparation platforms. These can meet diverse customer demands at R&D, bench-scale and pilot-scale stages. The company employs nearly 100 technical staff, and operates four laboratories plus a dry room. Our laboratories are equipped with FTIR spectrometers, Raman spectrometers, X-ray diffractometers, electrochemical mass spectrometers, electrochemical workstations, gas chromatographs, metallographic microscopes, charge-discharge testers and other analytical instruments, together with a full set of battery preparation equipment.

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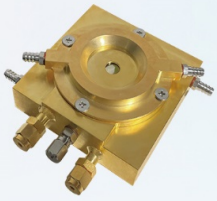
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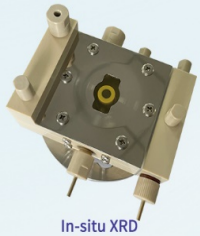
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DRONES & UAVs



Power storage and weight have constrained UAV flight times – until now!

- For unmanned surveillance aircraft, every gram of structure trades against endurance and payload.
- Conventional PV has been either too expensive (GaAs) or too heavy (Si) to be deployed on drones to extend endurance.
- Halocell prints flexible perovskite modules that can laminate to the airframe and wings, recharging batteries in flight and extending flight time by 3x.

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Orbital demand is scaling rapidly. Current supply is too expensive and too slow to meet demand.

- GaAs/GaInP (gallium arsenide / gallium indium phosphide) has been the primary solar material class in orbit over the last decades. It is also very expensive, brittle, and slow to make.
- Silicon PV is much cheaper than GaAs / GaInP but has lower performance, is much heavier and degrades rapidly in space conditions.
- Halocell has a cost-effective, flexible, lightweight space-grade perovskite module with a production process that can be easily scaled to meet growing demand.

Halocell has a low-energy, low-temperature, low-cost printing process

Roll-2-Roll

- R2R printing is the cheapest manufacturing method – with continuous, highly consistent output
- Energy costs are substantially lower: ~120°C for perovskite compared to >1200°C for silicon
- Avoids the slow, high-energy crystal-grown GaAs/GaInP process

Smart Chemistry

- Smart perovskite chemistry provides performance and durability
- Extremely difficult to reverse engineer
- Reducing material costs by substituting cost-effective alternatives
- Upgraded encapsulation and testing regime for the space market

Local Supply Chain

- Sourced from abundant materials, compared with GaAs/GaInP and silicon supply-chain constraints
- Made in Australia with circularity and full recyclability in mind

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Lava Blue is an Australian technology company developing hydrochloric acid processing routes for high-purity critical materials. Its modified HCl process uses low-grade minerals, mine wastes and industrial streams to create cleaner pathways to materials used in batteries, power electronics, advanced ceramics, semiconductors and next generation solar technologies.

Chloride chemistry is Lava Blue's core capability. The process supports high reagent recovery, all-electric operation and flexible feedstock selection, helping resource owners convert local streams into higher-value clean-energy inputs.

Shown here, PRiSM — Lava Blue's Centre for Predictive Research into Specialty Materials — is a renewable-energy powered pilot facility and R&D hub near Brisbane. It is where Lava Blue validates process conditions, product performance and operating frameworks before commercial scale-up.



PRiSM, Lava Blue's renewable-energy powered pilot facility and R&D hub near Brisbane.

That practical capability is strengthened by Lava Blue's long-running collaboration with Queensland University of Technology. Since 2018, Lava Blue and QUT have combined chemistry, characterisation, machine learning and pilot engineering to de-risk specialty materials for industry.

Why it matters

HCl processing	Renewable-powered PRiSM	QUT collaboration
Selective chloride chemistry for high-purity critical materials.	Pilot-scale validation of processes, products and operating conditions before scale-up.	Applied research, advanced characterisation and workforce development supporting commercial outcomes.

For NextGem 2026, Lava Blue brings together Australian science, renewable-powered piloting, proprietary HCl processing know-how and collaborative pathways to scale.

Nano-Micro Letters

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38.5 Q1

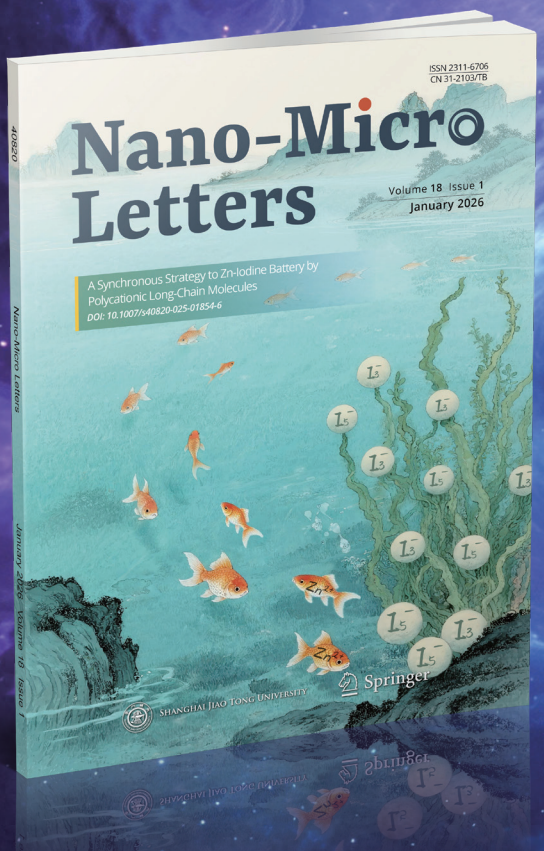
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2/148 (Nanoscience & Nanotechnology)

2/191 (Physics, Applied)

5/472 (Materials Science, Multidisciplinary)

Indexed by SCI, EI,SCOPUS, DOAJ, PubMed Central, CSCD, CNKI, *etc.*



Report Scope

Focuses on but is not limited to the following areas

- Artificial synapse device
- Batteries
- Electrocatalysis/Photocatalysis/Photoelectrocatalysis
- Energy Storage and Conversion
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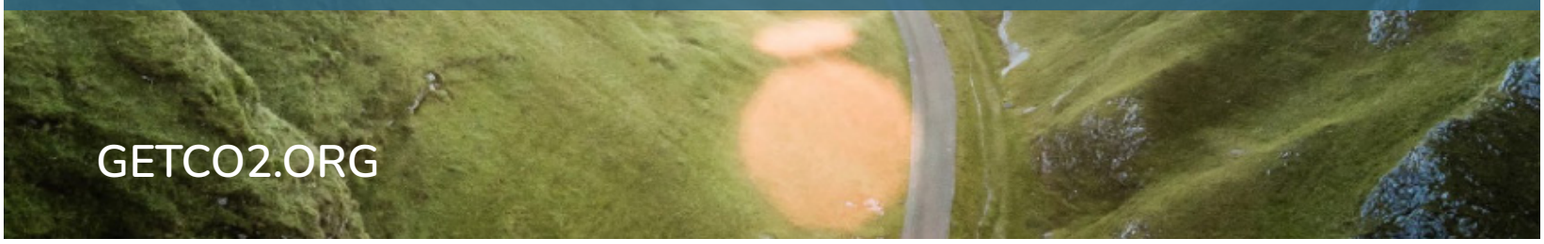
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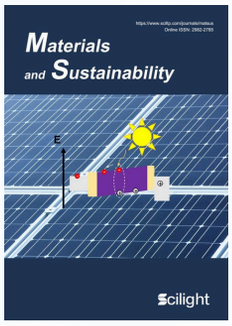
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Journal Introduction



Materials research plays a crucial role in driving sustainable processes, a pivotal element for the global transition towards sustainable living on earth. Breakthroughs in this field often stem from robust cross-disciplinary approaches that bridge different domains. A significant societal task is the implementation of new manufacturing processes geared towards a more sustainable utilization of resources.

Journal Scope

This journal is dedicated to the exploration ofmaterialresearch,emphasizing its contribution to achieving a more sustainable use of resources. This encompasses advancements in renewable energy sources, the development of more efficient processes, establishment of sustainable lifecycles for materials and products, a refined understanding of current processes serving as a foundation for optimization towards sustainable devices, and innovative fabrication methods.

Specifically, the journal focuses on the role of materials research in energy harvesting and storage, recycling, green and novel fabrication processes. This includes the enhancement of renewable energy sources, a comprehensive understanding of functionalities, the creation of novel devices for energy conversion and storage, and the integration of sustainable processes such as recycling and energy-saving methods. Emphasis is placed on exploring novel material combinations, promoting the use of more sustainable materials, advancing material synthesis, delving into nanomaterials, and conducting structural investigations for improved device applications, considering factors like stability, efficiency, fabrication technology, and integration into functional devices. The integration of machine learning is recognized as a promising tool to enhance and expedite progress in this dynamic field.

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Energy harvesting and storage

- Pioneering material advancements for optimized renewable energy sources (solar, wind power, hydropower, etc.)
- Solar energy innovations (solar-to-electricity, heat, fuel)
  - Photovoltaic technologies (inorganic, organic, perovskite, and other emerging technologies)
  - (Photo-)catalysis, water splitting, CO2 reduction, fuel cells
- Innovative (nanostructured) devices (nanogenerators, self-powered devices, thermoelectric, ⋯)
- Advanced energy storage solutions (batteries, capacitors, supercapacitors, hydrogen storage, ⋯)

Advancing recycling and energy-efficient materials and Processes

- Promoting energy-efficient materials and energy-saving processes
- Developing recyclable materials
- Advancing green fabrication methods and materials
- Pioneering novel material-based investigation tools and technologies for a greener and more sustainable world

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- Materials driving sustainable development
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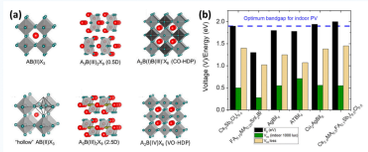
Materials and Sustainability

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Lead-Free Perovskite and Perovskite-Inspired Materials for Indoor Photovoltaics: A Perspective

Jung Ho Yun and Miaoqiang Lyu etc.
Kyung Hee University, Republic of Korea
The University of Queensland, Australia

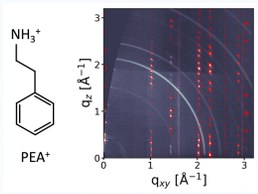
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Unravelling the Formation of 2-Phenylethylammonium 2D Perovskites by In Situ GIWAXS

Ivan Zaluzhnyy and Frank Schreiber etc.
Universitat Tubingen, Germany

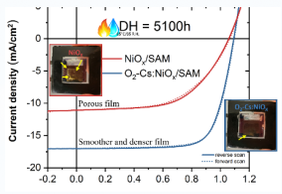
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Stabilizing the Chemistry of NiOx in Perovskite Solar Cells to Pass the Damp Heat Test

Marion Dussouillez and Adriana Paracchino etc.
CSEM Sustainable Energy Center, Switzerland

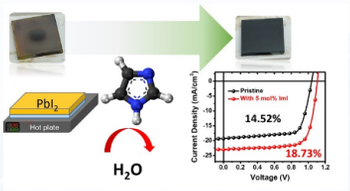
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High-Efficiency Perovskite Solar Cell with an Air-Processable Active Layer via Sequential Deposition

Wei-Fang Su and Yu-Ching Huang etc.
Ming Chi University of Technology, Taiwan

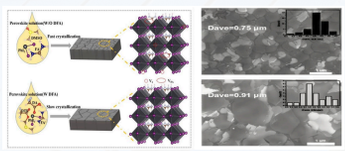
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Additive Engineering in Crystallization Regulation of Highly Efficient Perovskite Solar Cell

Molang Cai etc.
North China Electric Power University, China

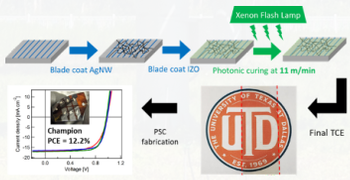
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"Green" Fabrication of High-performance Transparent Conducting Electrodes by Blade Coating and Photonic Curing on PET for Perovskite Solar Cells

Julia W. P. Hsu etc.
University of Texas at Dallas, USA

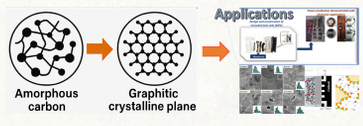
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An Overview of the Transition from Amorphous Carbon to an Ordered Graphitic Crystalline Plane for Applications

Sathish-Kumar Kamaraj etc.
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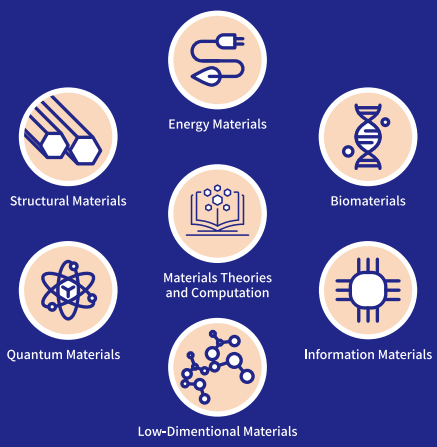
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ABSTRACTS BOOK

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Day 1

Monday, 28 September 2026

Prof. Alex Kwan Yue Jen

City University of Hong Kong, Hong Kong SAR

Day 1: 08:45-09.20, Plenary Talk

Title: Molecular engineering of hybrid materials for highly efficient and stable organic and perovskite solar cells

Abstract: We employed a crosslinkable co-SAM to enhance the conformational stability of hole-selective SAMs against external stresses, while suppressing the formation of defects/voids in SAM simultaneously during self-assembly. This effectively hinders the exposure of substrate surface caused by wiggling of loose SAMs under thermal stress to prevent perovskite decomposition. A certified PCE of 26.92% was achieved while possessing excellent thermal stability with negligible decay under maximum-power-point (MPP) tracking at 85 °C for 1,000 hours. It also retains >98% of initial PCE after 700 repetitive thermal cycles between -40 °C and 85 °C, representing the forefront result of the field. We also developed a method to reduce the photovoltage loss of wide-bandgap (WBG) PSCs by constructing a localized 2D/3D perovskite heterojunction at the buried interface. This significantly reduced defect density and facilitated charge extraction and perovskite crystallization without compromising bulk optoelectrical properties of 3D perovskite, leading to a record V_{oc} of 1.382 V for 1.79 eV-PSC, exceeding 90% of its SQ limited value. The device retained 95% of its initial PCE (21.2%) after MPP tracking for over 700 h. A perovskite-organic tandem cell was fabricated by integrating this WBG PSC to achieve a high PCE of 28.5%. In addition to work on PSCs, we have also experimentally shown that T_1 excitons can be re-dissociated, through the interfacial charge-transfer (CT) state, to form free carriers in an OPV system incorporating a non-fullerene acceptor (NFA) with a narrowed singlet-triplet gap. We elucidate how the orbitals distribution in the molecule and exciton delocalization in aggregates affect the singlet-triplet energetics of the acceptor in condensed phase, rendering the controllable traffic between T_1 and spin-triplet CT states. By introducing this acceptor as a ternary component into other host OPV systems, we manage to recover the triplet-mediated losses and improve OPV efficiencies by maximizing the number of extractable photocarriers.

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Alex Jen is the Lee Shau-Kee Chair Professor and Founding Director of the Hong Kong Institute for Clean Energy at the CityUHK. He published more than 1,250 SCI papers with >115,000 citations and an H-index of 175. He also co-invented 73 patents and invention disclosures. He was elected as Academician by the European Academy of Sciences and as Fellow for several prestigious professional societies, including AAAS, MRS, ACS, PMSE, OSA, and SPIE. He was named by the Times Higher Education (THE) in 2018 as a "Top 10 University Researchers in Perovskite Solar Cell Research". In addition, he was recognized by Thomson Reuters as one of the "World's Most Influential Scientific Minds in 2015 and 2016 and by Clarivate as a "Highly Cited Researcher" in Materials Science from 2014-2025.

Prof. Yun Liu
The Australian National University, ACT2601, Australia,

Day 1: 09:20-09.55, Plenary Talk

Title: Introduction to the newly built full structure data of materials that greatly extend traditional crystallography

Abstract: Materials form the foundation for all emerging technologies. Traditionally, materials research has focused on establishing relationships between macroscopic structures—such as average structures determined by X-ray crystallography and various diffraction techniques—and material properties. Solid-state materials can be modified through multiple approaches to achieve peak performance or create new functionalities: chemical doping, ion substitution, entropy engineering, structural amorphization or crystallization, and fabrication in various forms (ultrathin films, nanomaterials, and 2D structures). However, in many of those cases, establishing clear structure-property relationships becomes increasingly complicated and often unattainable. The main reason is because in strongly correlated solid-state systems, extrinsic atoms or ions can be accommodated differently in local regions—both structurally and chemically—without altering the average structure. Consequently, the influence of doping and substitution on material properties is often not straightforward. This complexity intensifies when materials are reduced to the nanoscale, where surface and interface effects in e.g. nanomaterials and ultrathin films become significant. Such complicated local chemistry and structure create substantial impacts on properties that cannot be explained by average structure analysis alone. In this talk, I will present several examples to demonstrate the local consequences of ionic doping and substitution and their impact on physical properties. These examples showcase the urgent need to move beyond traditional crystallography to obtain more precise chemical and structural information by extending from micrometre-scale average structures to multiscale, full structural characterization down to the atomic level. For this sake, I hereof will discuss a new method for materials' structural determination and introduce our newly developed **Full Structure Data of Materials (FSDM)**, which will greatly extend the traditional crystallography data, bringing the potential to accelerate discovery and innovation in materials science for generations to come.



ANU Distinguished Professor Yun Liu is an internationally recognised leader in materials chemistry and polar functional materials. She completed her PhD at Xi'an Jiaotong University in 1997, held AIST and STA Fellowships in Japan (1998–2001), and joined ANU in 2001, leading its Functional Materials Research Group since 2006. She was awarded the ARC QEII, Future and Australian Laureate Fellowship. She is a Fellow of the Australian Academy of Science, ATSE, AIP and RACI, and currently chairs the Asian Electroceramics Association. Her research investigates the defect and crystal chemistry of solids, linking chemistry, structure and properties to guide the design of new functional materials.

Prof. Shengzhong (Frank) Liu

Day 1: 09:55-10:30, Plenary Talk

Title: Large-area scaleup preparation for perovskite solar cell production

Abstract: The ABX_3-type perovskite structure appears to be a wonder for a wide spectrum of applications including piezo-, ferro-, antiferro-magnetism, antiferro-electricity, superconductivity, catalysis, etc. In particular, the organic-inorganic hybrid lead-halide-based perovskite has demonstrated amazing properties in photovoltaic, optoelectronic and photoelectronic applications. In only a few years since the thin-film type perovskite solar cell was reported in 2012, its solar cell efficiency has surpassed 27%, higher than all other thin film solar cells. In this presentation, I'll cover research and developments in my groups on perovskite solar cells. In particular, I'll report our effort in scaling up fabrication. With support from industry, we have successfully designed and setup a pilot production line for square-meter size panels. Upon its success in attaining high efficiency and stability, a 200 MW production line is successfully built, with 1600x1200 (mm^2) sized panel efficiency exceeding 19%. In summary, solar module efficiency for 1200x650 (mm^2) panel is about 20%. Figure 1 shows a kW-scale solar power plant installed with an assembly of 20 high-efficiency solar panels. We are pleasantly surprised by no detectable degradation observed over a period of about two years.



Figure 1: kW-scale power plant installation of perovskite solar cells.



Dr. Shengzhong Liu received his PhD from Northwestern University, USA in 1992. He is an RSC (Royal Society of Chemistry) Fellow. His H-index is over 130 and i10-index over 400. Upon completing his postdoctoral research at Argonne National Laboratory in 1994, he joined high-tech industrial research, most notably on solar cells with Solarex/BP Solar and United Solar Ovonic. Professor Liu's research focus includes nanomaterials, thin film materials, photovoltaic materials and solar cells. His major outcome in basic research has been published in scientific journals, including Science, Nature, Nature Energy, Joule, Matter, Science Advances, Nature Communications, Advanced Materials, Energy & Environ. Sci., etc. many of them being enlisted in ESI's "most cited paper" and "hot paper" lists. Many of his major inventions and patents have been converted into commercial technology and products. In 2012, he accepted a full-time professorship by Shaanxi Normal University and Dalian Institute of Chemical Physics, Chinese Academy of Sciences. He is now the director of Shaanxi Engineering Lab for Advanced Energy Technology, Shaanxi Key Laboratory for Advanced Energy Devices and Institute for Advanced Energy Materials, Shaanxi Normal University and Associate Director of Solar Energy Department, Dalian National Laboratory for Clean Energy. He serves as an associate Editor for NanoSelect. He is also an Editorial Board Member for Advanced Science, ACS Sustainable Chemistry & Engineering, J. Energy Chemistry and Scientific Report. He is selected as the top 1% most highly cited author by RSC and Clarivate Analytics. He is also enlisted among the "Top 2% Scientists Worldwide".

Room #1: Catalyst 1A

Prof. Chuan Zhao

University of New South Wales, Sydney, Australia

Day 1: 10:50-11:10, Keynote Talk

Title: Earth-Abundant Electrocatalysts for Hydrogen Energy Conversion

Abstract: Hydrogen holds the promise as green energy carriers for global scale storage of renewable energy, e.g., solar and wind, enabling the continuous usage of these diffusive and intermittent energy sources. Electrochemical energy-conversion devices such water electrolysers, CO_2 electrolysers and fuel cells are cornerstone technologies for decarbonisation and hydrogen economy, which requests highly efficient, low cost, and robust catalyst materials to reduce its current levels of energy consumption and cost. However, currently there is a gap between lab-scale research and industrial scale application, effectuated by catalysts, cell design, and operation conditions. This talk highlights the current challenges and opportunities for electrochemical energy-conversion devices, from materials and device engineering perspectives. I will showcase our efforts in developing Earth-abundant electrocatalysts for oxygen evolution reactions (OER), hydrogen evolution reactions (HER), oxygen reduction reactions (ORR), CO_2/CO reduction reactions, as well as operando methodologies for understanding the catalytic processes and degradations in membrane electrode assemblies The commercialisation of some our work for industry also will be introduced to highlight the significance of material design from atomic to macroscopic to industrial scale.



Biography: Prof Chuan Zhao is an Australian Laureate Fellow and Fellow of Australian Academy of Technological Science and Engineering (FTSE) at UNSW. Prof Zhao received his PhD with an excellence award from Northwest University, then completed postdoctoral research at University of Oldenburg and Monash University, before starting his independent career in UNSW in 2010. He is interested in discovering electrochemical methods and materials for applications in water splitting, fuel cells, CO_2 reduction, aqueous batteries, and sensors. He has received numerous awards including the most distinguished Australian Awards in Chemistry and Electrochemistry, RACI HG Smith Memorial Award and R.H. Stokes Medal, respectively, as well as the Liversidge Awards and Lectureship from the Royal Society of New South Wales.

Prof. Fuxiang Zhang
Dalian Institute of Chemical Physics (DICP), China

Day 1: 11:10-11:30; Keynote Talk

Title: Solar hydrogen production from water over particulate photocatalysts with wide visible light utilization

Abstract: Solar hydrogen production via overall water splitting (OWS) over particulate photocatalysts is one of the most promising ways for artificial photosynthesis [1-2]. It is general to know that wide visible light utilization is another important issue to achieve theoretically high solar-to-hydrogen (STH) conversion efficiency beyond the OWS process with very positive Gibbs free energy change. However, it confronts huge challenges in addressing the sluggish carrier transfer kinetic and surface catalysis, as caused by the narrowed bandgap. In the past decades, accordingly, increasing interests in this field have been paid to developing materials to capture and channel wide range of sunlight; deepening understanding of artificial photosynthesis; and discovering new catalysts to make the chemistry possible and efficient. In this talk, I will present our recent research progress about the solar hydrogen production via redox-mediated Z-scheme overall water splitting of powder photocatalysts from the view of developing novel materials and fabricating photocatalytic systems [3-17]. Meanwhile, strategies promoting charge separation and surface catalysis etc. will be also discussed and shared.

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Biography



Dr. Zhang earned his Ph. D. at Nankai University in 2004 and pursued his postdoctoral research at the University of Pierre & Marrie Curie and the University of Tokyo from 2008 to 2011, separately. Since October 2011, he has been working at Dalian Institute of Chemical Physics (DICP) for solar-to-chemical energy conversion with an emphasis on wide visible light utilization. To date, he has published series of over 200 SCI papers in some peer-reviewed journals such as Nat. Catal. Nat. Commun., Joule, JACS and Angew. Chem. Int. Ed. etc..

Assoc. Prof. Ken Chiang
RMIT University, Australia

Day 1: 11:30-11:45 AM, Invited Talk

Title: Gallium-Based Alloy Catalysts for Small-Molecule Activation: From Dynamic Interfaces to Thermocatalytic Selectivity

Abstract: Gallium-based alloy catalysts are emerging as an alternative platform for thermocatalytic reactions involving small and chemically stable molecules. Beyond its role as a low-melting solvent metal, gallium can modify the geometric, electronic and interfacial properties of catalytically active metals, giving rise to distinct catalytic behaviour in alloy, intermetallic, oxide-associated and liquid-metal states. These features are particularly relevant to reactions such as ammonia synthesis, CO_2 hydrogenation, alkane dehydrogenation and methane reforming, where activity and selectivity are governed by the activation of strong bonds and the controlled formation of surface intermediates.
This presentation will discuss recent developments in gallium-based alloy catalysts, with emphasis on how alloy composition, phase state, surface oxidation and metal-metal interactions influence catalytic performance. Particular attention will be given to CuGa systems, which are a current focus in our research group. CuGa alloys provide a useful model for exploring how gallium modifies copper-based catalysis, including the formation of CuGa, Cu-GaO_x and liquid metal derived interfacial structures. These structures may influence the adsorption and activation of molecules, stabilisation of intermediate and C-C coupling pathways. By linking recent literature with our ongoing work, this talk will highlight how gallium-based alloys can be designed beyond conventional solid catalysts, and how dynamic alloy and oxide interfaces may open new opportunities for thermocatalytic conversions.

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Biography



Ken Chiang is an Associate Professor in Chemical and Environmental Engineering at RMIT University. His research focuses on catalysis, liquid metals, CO_2 utilisation, hydrogen production and sustainable chemical technologies. Before joining RMIT, he held research leadership roles at CSIRO, working on industrial catalysts, syngas conversion, synthetic fuels and low-emission technologies. At RMIT, he leads translational research in liquid-metal catalysis and decarbonisation, including gallium-based systems for converting CO_2 into solid carbon. His work bridges fundamental catalyst design and applied engineering to develop scalable technologies for carbon utilisation, renewable energy and sustainable industrial processes.

Dr. Dechao Chen
University of Southern Queensland, Australia

Day 1: 11:45-12:00, Invited Talk

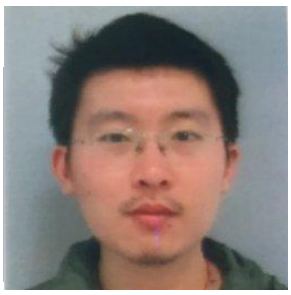
Title: Heavy-Metal-Free Quantum Dot Heterostructures for Selective Solar-to-Chemical Conversion

Abstract: Colloidal synthesis using Ligand mediated surface engineering is a powerful approach to manifest the physical and chemical properties of quantum dots. [1,2] We present a colloidal synthesis method to attract high-quality carbon quantum dots with surface ligand-induced dual emission through a colloidal synthesis strategy. [3] The colloidal synthesis improved the quality of carbon dots in its size control and uniformity. The colloidal carbon dots showed the improved quantum yield and surface passivation induced dual emission. The results revealed the surface function and interactions. Benefitting from the good optical and colloidal stability, a new class of van der Waals heterojunction photocatalyst, which is synthesized by hot-injection method, whereby carbon dots (CDs) are grown in situ on ZnSe nanoplatelets (NPLs), i.e., metal chalcogenide quantum wells. [4] The resultant organic-inorganic hybrid nanoparticles, CD-NPLs, are able to perform methanol dehydrogenation with the occurrence of α-C-H splitting and C-C coupling. The novel CD-based organic-inorganic semiconductor heterojunction is poised to enable the discovery of a host of new nano-hybrid photocatalysts with full tunability in the band structure, charge transfer, and divergent surface chemistry for guiding photoredox pathways and accelerating reaction rates.

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Biography



Dechao Chen is an Australian Research Council Discovery Early Career Researcher Award (DECRA) Fellow at the Centre for Future Materials, School of Science, Engineering and Digital Technologies, University of Southern Queensland (UniSQ). Before he joined UniSQ in 2026, he was a research fellow at the Advanced Technologies Research Institute (QUATRI) and the School of Science at Griffith University. He received his Ph.D. in Chemistry from Curtin University. His research focuses on the synthesis of environmentally friendly quantum dots and their applications in photocatalysis and optoelectronics.

Room #2: Solar 1

Prof. Shuzi Hayase
The University of Electro-Communications, Japan

Day 1: 10:50-11:10, Keynote Talk

Title: Distinct Roles of Germanium Anion Additives in DMSO-Based and DMSO-Free Inks for Tin-Based Perovskite Solar Cells

Abstract: This report focuses on Sn-based perovskite solar cells with an inverted structure of FTO/HTL/Tin-based perovskite/ETL/Ag. We have previously reported that adding a small amount of GeI2 to Pb-perovskite ink and Sn-based perovskite inks improve both cell efficiency (1,2) and stability at 85 °C (3). These improvements were attributed to the surface passivation of the perovskite layer by SnOxIt derived from GeI2, which diffuses to the interfaces during the crystallization of Sn-based perovskites (3, 4). Although the oxidation mechanism of GeI2 remained unknown in our previous study, here we report that GeI2 in the ink is oxidized by DMSO within the perovskite ink. Notably, when GeI2 was added to a DMSO-free ink, the solar cell efficiency decreased. In conclusion, a DMSO-based ink is essential for the GeI2 additive to function effectively. We have also reported that cells fabricated from the DMSO-based ink exhibited lower stability than those from the DMSO-free ink. To leverage the advantages of both the DMSO-free ink and the GeI2 additive, we introduced a vacuum-deposited GeOxIy layer between the HTL and the Sn-based perovskite layer prepared from the DMSO-free ink. The G2OxIy layer functions effectively in Sn-based perovskite devices prepared from the DMSO-free inks (5). This outcome is further supported by recent calculation (6). GeOxIy serves as a valuable passivation layer.

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Biography



Shuzi Hayase received his Ph.D. from Osaka University in 1983, after completing his graduate studies there in 1978. He joined the R&D Center at Toshiba Corporation in 1978, where he worked until 2000. From 2001 to 2019, he served as a Professor at the Kyushu Institute of Technology (KIT), and from 2016 to 2018, he held the positions of Executive Director and Vice President of KIT. Since 2019, he has been a Professor at the University of Electro-Communications (UEC). From 2009 to 2017, he was also a Supervisor of the PRESTO project (JST), “Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells.” His numerous honors include the Innovative PV Award (2024), the Hamakawa Award from the Japan Solar Energy Society (2022), and Fellowship of The Society of Polymer Science, Japan (2020), among others.

Prof. Yeng Ming Lam
Nanyang Technological University, Singapore

Day 1: 11:10-11:30, Keynote Talk

Title: From Structure to Function: Interface Design in Energy Harvesting and Conversion Devices

Abstract: The performance of thin-film devices is fundamentally shaped by their interfaces, and designing novel interfaces requires a detailed understanding of the structures and interaction energies at play. In this presentation, two case studies on energy harvesting and energy conversion will be shown. For electromechanical coupling materials, such as piezoelectric materials, traditional methods to induce instability thin films to increase electromechanical responses generally involve complex chemical compositions, compromising stability and increasing costs. In this presentation, I will share with you a new strategy to enhance electromechanical response by inducing competition between antiferroelectric (AFE) and ferroelectric (FE) phases in sodium niobate ($NaNbO_3$, NNO) thin films. The coexistence of AFE and FE phases can create structural instabilities, thereby enhancing the electromechanical response. We synthesized epitaxial NNO thin films with orthorhombic AFE and rhombohedral FE phases, achieving an ultrahigh effective piezoelectric coefficient (~5000 pm/V).[1] In solar energy harvesting application, there are two critical performance indicators – efficiency and stability. Two layers combination making up of three-dimensional (3D) perovskite capped with low-dimensional (LD) perovskites interface layer have shown be an effective strategy in resolving the compromise that we have to live with for hybrid perovskites – compromise between photovoltaic efficiency and operational stability. In the study, instead of the conventional LD capping layers containing Pb^{2+} or Sn^{2+}, we showed that using different materials synthesis strategies, it is possible to access a wider cation library for these capping layers. Through this method, high efficiency and stable hybrid perovskite cells can be achieved.[2,3]

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Bio: Yeng Ming LAM (FRSC) received her Ph.D. degree in Materials Science and Metallurgy from the University of Cambridge, UK, in 2001. She is currently a Professor and holds the President's Chair in Materials Science and Engineering. Yeng Ming is also the Director of the Facility for Analysis, Characterization, Testing and Simulations (FACTS), a university facility for advanced characterization using electrons and X-ray since 2016. She is also currently the chair of the Research Evaluation Council for NTU. She was the Chair of the School of Materials Science and Engineering (MSE), NTU, from Jan 2019 to Dec 2024. Her research aims to understand and design novel nanostructured functional nanomaterials for application in sustainable energy, sustainable food production and also environment remediation. She is the co-Chair of the governing board for International Symposium for Polymer Analysis and Characterization (ISPAC), USA. She held a concurrent Senior Scientist position in RWTH University in Aachen, Germany, between 2011 and

2014 and a concurrent Senior Scientist position in IMRE, A*Star, from 2010-2011. She was awarded the inauguration L'Oréal UNESCO For Women in Science National Fellowship and the Nanyang Outstanding Young Alumni Award in 2009. In 2024, she was awarded the ASEAN-US Science Prize for Women (Senior Category, First Prize). In 2025, she was named Top 50 Asia Women Tech Leaders 2025 and is the SEARCA Regional Professorial Chair 2025-2026. She was awarded American Chemical Society (ACS) Salute to Excellence Award and she is also the elected Academician of Asia Pacific Academy of Materials (APAM) in 2025.

Prof. Jianjun Li
University of Science and Technology of China, China

Day 1: 11:30-11:45, Invited Talk

Title: Charge carrier loss mechanisms at grain boundaries and junction interfaces of keserite thin-film solar cells

Abstract: Kesterite thin-film solar cells are rising as one of the most sustainable thin-film PV technologies. However, charge carrier recombination at grain boundaries and interfaces have been identified as the bottleneck factors limiting device performance[1]. In this talk, we discuss the charge carrier loss mechanisms at grain boundaries and junction interfaces of kesterite $Cu_2ZnSnSe_4$ thin-film solar cells. The analytical models describing these two recombination processes will be discussed and the methodologies derived thereof for diagnostic analysis will be demonstrated.

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Dr. Limei Yang
Queensland University of Technology, Australia

Day 1: 11:45-12:00, Invited Talk

Title: Focused Ion Beam sample preparation for Atom Probe Tomography

Abstract: In modern solid materials characterization, focused ion beam (FIB) lift-out is an essential technique for fabricating small-scale specimens for transmission electron microscopy (TEM) and atom probe tomography (APT) studies. APT is a powerful technique that can provide quantitative analysis with both high spatial and chemical resolution. This presentation focuses on the applications of APT in material science, geological science and also biological science. A simple and effective sample fabrication methodology using a rotatable micromanipulator in FIB is also introduced. This method enables a quick and precise location of regions of interest (ROI) and leads to better quality samples with high success rates for APT analysis. The success in preparation will be demonstrated on nanoparticles, nanowire, and thin films, which are typically challenging for sample preparation.

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Biography



Limei Yang completed her PhD at the University of Wollongong before undertaking postdoctoral research at the Ohio State University, where she specialized in shape memory alloys and advanced materials characterization using transmission electron microscopy (TEM).
In 2013, she joined the University of Sydney, focusing on advanced materials characterisation techniques, including focused ion beam (FIB), atom probe tomography (APT), and transmission TEM.
Dr Yang is currently a Lecturer at the University of Technology Sydney (UTS). Her research focuses on the development and characterization of advanced materials for energy conversion and storage, with application in batteries, hydrogen technologies, solar energy, and thermal energy systems.

Lahiru Nimantha Jayasekera Gamage
Queensland University of Technology, Australia

Day 1: 11:45-12:00, Oral Talk

Title: Design of Sustainable Solvent Systems for Metal Halide Perovskite Photovoltaics

Abstract: Following their introduction to photovoltaics in 2009 with a 3.8% efficiency[1], metal halide perovskites have rapidly evolved to a record single-junction cell efficiency of 28%. This progress is driven by favourable properties, including direct bandgaps ideal for visible light absorption, bandgap tuneability, long charge-carrier diffusion lengths, low-cost solution processability, and high defect tolerance[2]. However, widespread commercialisation is severely hindered by the reliance on highly hazardous polar aprotic solvents during fabrication[3]. While greener alternative solvents demonstrate significant promise, current selection methods depend largely on empirical descriptors such as the Gutmann donor number. This conventional approach is fundamentally flawed as it fails to capture critical steric effects, binding persistence and the evolution of solvated intermediate phases prior to crystallisation[4]. To address this limitation, this research establishes a predictive computational-experimental framework to rationally design sustainable solvent systems. Computationally, density functional theory is employed to calculate electronic descriptors, binding energetics, and preferred coordination motifs between proposed green solvents and lead-halide complexes. These theoretical models are supplemented with physical experimental screening to evaluate solvent coordination behaviour. This study systematically links these computationally derived descriptors to crystallisation dynamics by experimentally tracking intermediate phase lifetimes and transformation pathways. High-speed optical and optoelectronic characterisations are utilised to monitor nucleation, growth fronts, and defect-related quenching as the films form.This integrated methodology further evaluates how residual solvent coordination and steric profiles influence optoelectronic defect formation and moisture resistance within the final crystallised films. Ultimately, this framework will forward-predict optimal, non-toxic solvent systems that match or exceed the film quality of benchmark traditional solvents. The most viable candidates will undergo rigorous device-level validation through macroscopic drift-diffusion simulations and the physical fabrication of full solar cell devices, paving the way for safer, regulatory-compliant commercialisation of perovskite photovoltaics.

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Room #3: Battery 1

Prof. John Zhu
The University of Queensland, Australia

Day 1: 10:50-11:10, Keynote Talk

Title: High Performance Cathodes for Solid Oxide Fuel Cells

Abstract: Solid oxide fuel cells **(**SOFCs) can effectively convert the chemical energy of fuels into electricity at an efficiency up to 60%. They typically operate at high temperature (800-1000^{o}C) resulting in high costs, materials compatibility and durability challenges. Developing SOFCs that can work at intermediate temperature (500-750 ^{o}C) has thus been attracting considerable attentions. The performance of the cathode is the largest hurdle to the full realization of low temperature SOFCs. In this talk, we will introduce our recent studies on novel cathode materials for highly efficient oxygen reduction reaction in SOFCs,[1-2] as well as our commercial development in our group.

Key words: solid oxide fuel cells, cathodes, low temperature

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Biography



Dr John Zhu is a professor in the School of Chemical Engineering, The University of Queensland, Australia. His research interests exist in advanced catalysis, gas/liquid adsorption and separation, solid oxide fuel cells and solid oxide electrolysis cells with applications in clean energy and environment. His publications include one edited book, 8 book chapters, and over 380 journal papers, with citations over 40000 times and h-index 100. He holds 11 patents, 6 patents have been licensed to the industrial sponsor. His research on solid oxide cells led to the establishment of two companies.

Prof. Qing Wang
National University of Singapore, Singapore

Day 1: 11:10-11:30, Keynote Talk

Title: Redox-mediated Electrified Chemistry for Scalable Carbon neutral Energy Applications

Abstract: Electrochemical energy conversion and storage technologies are central to global sustainable development. At the heart of these systems are redox reactions, in which charge transfer occurs at the electrode–electrolyte (E–E) interface. Batteries, fuel cells, electrolyzers, and many other electrochemical devices are therefore inherently governed—and often constrained—by interfacial processes. Despite two centuries of remarkable progress, conventional E–E-interface-centric electrochemical systems face growing challenges in emerging applications involving open systems and distributed resources, such as solar energy, water, air, and recyclable feedstocks. These systems often involve dynamic interfaces, formation of new phases, continuous feedstock supply, and product removal, all of which impose constraints on efficiency, scalability, and durability. In this talk, I advocate a conceptual transition **from electrochemistry to redox-mediated electrified chemistry**, centred on redox-mediated reactions of energy materials. By employing soluble redox mediators as mobile charge carriers in regenerative electrochemical–chemical (EC–C) loops, this approach enables charge generation at electrodes while relocating storage, catalysis, separation, and chemical transformation to independently optimized environments. In doing so, redox-mediated electrified chemistry extends electrochemical reactivity beyond the electrode surface and provides new flexibility for overcoming the intrinsic limitations of conventional electrochemical processes. This framework opens opportunities for a broad range of scalable carbon-neutral energy technologies, including large-scale energy storage, metal–air fuel-cell power generators, decoupled water splitting, precision electrosynthesis, resource recycling, and beyond.

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Biography



Dr. Qing Wang is a Provost's Chair Professor at the Department of Materials Science and Engineering, National University of Singapore. He obtained Ph.D. in Physics at the Institute of Physics, Chinese Academy of Sciences in 2002. Before he moved to Singapore, he had worked in École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, and National Renewable Energy Laboratory (NREL), USA, on mesoscopic photoelectrochemical cells. His research interest is "*Charge Transport in Mesoscopic Energy Conversion and Storage Systems*". Presently, his team is extensively engaged in pioneering research within a novel framework of redox-mediated electrified chemistry, with the implementation of the redox-targeting concept to a wide variety of battery chemistries and energy materials for advanced energy related applications.

Assoc. Prof. Zheng Liang
Shanghai Jiao Tong University, Shanghai, China

Day 1: 11:30-11:45, Invited Talk

Title: Direct Repair of Spent Li-ion Batteries

Abstract: With the development of renewable energy industry, the use and waste of lithium-ion batteries are increasing day by day. China relies heavily on imported lithium and cobalt resources, so it is of strategic significance for the renewable energy industry to develop battery recycling technique and realize resource sustainability. The existing pyrometallurgical and hydrometallurgical recycling methods are based on molecular structure destruction and re-extraction, which requires extreme conditions, such as high temperature and corrosive agents, to destroy the molecular structure because the covalent bonds in the cathode materials are very stable, and the subsequent separation and extraction steps are lengthy. As a result, the overall economic and environmental benefits need to be improved. The direct repair method has a greater potential to repair battery materials especially cathode materials at the molecular scale and shorten the recovery process from the principle. However, due to the lack of understanding of the mechanism, the existing direct repair method takes "lithium replenishment" as the only means and simply borrows the existing lithium replenishment method, ignoring the series of problems caused by the continuous phase transition in the actual material failure process, so its actual large-scale application has not been reported yet. After a long period of research, the applicant realized that direct repair is the inverse process of material failure, and the key is to deeply reveal the mechanism of continuous phase transition during the failure process, so as to guide the design of recycling methods that can be applied on a large scale, and finally realize the direct repair of actual end-of-life battery materials.

Key Words: Li-ion batteries; battery recycling; energy storage materials



Short Biography: Zheng Liang obtained his Ph.D. degree in Professor Yi Cui's research group at Stanford University in 2018. After three years of postdoctoral research experience at Stanford University and Lawrence Berkeley National Laboratory (under the supervision of Professor Gabor A. Somorjai), he began his independent academic career as an associate professor at Shanghai Jiao Tong University, with research interests in next-generation energy-storage materials for Li-ion and Li-metal batteries, as well as their recycling strategies.

Bhagya Dharmasiri
Deakin University, Australia

Day 1: 11:45-12:00, Oral Talk

Title: Manipulation of Carbon Fibre Surface Chemistry for Structural Batteries and Structural Supercapacitors

Abstract: Structural energy-storage composites offer a pathway towards lightweight systems that simultaneously carry mechanical loads and store electrical energy. However, the chemically inert surface of commercial carbon fibres limits electrochemical activity, interfacial interactions and multifunctional performance. This presentation highlights our recent work demonstrating how carbon fibre surface chemistry can be engineered to enable both structural supercapacitors and safer aqueous zinc-based structural batteries. For structural supercapacitors, electrochemical grafting was employed to introduce tailored functional groups that regulate interactions between carbon fibres and $Ti_3C_2T_x$ MXenes. Amine-functionalised fibres promoted uniform MXene deposition, increasing capacitance to 157 F g^{-1} and improving fibre-matrix interfacial shear strength by 54%. Translation to woven electrodes produced structural supercapacitors with capacitances up to 908 mF g^{-1}, demonstrating the effectiveness of molecular-level interface engineering. The same surface-engineering strategy was extended to zinc-based structural batteries by modifying carbon fibres to support conformal Zn/ZnO anodes and MnO_2 cathodes within a structural laminate. Surface modification improved electrochemical kinetics by reducing ion diffusion resistance while simultaneously increasing interlaminar shear strength by approximately 59%, illustrating the ability to achieve electrochemical and mechanical enhancement within a single architecture. While these studies demonstrate that carbon fibre surface chemistry is a powerful design parameter for multifunctional composites, significant challenges remain. Trade-offs between electrochemical performance and structural integrity, limited ionic conductivity of structural electrolytes, and the lack of standardised multifunctional performance metrics continue to restrict practical implementation. Future research should focus on scalable surface chemistries, coupled electrochemical-mechanical optimisation, and holistic laminate-level design to realise high-performance structural energy-storage composites.

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Room #4: Catalyst 1B

Prof. Rachel Caruso
RMIT University, Australia

Day 1: 10:50-11:10; Keynote Talk

Title: Photocatalytic and Electrocatalytic Materials for Energy and Environmental Applications

Abstract: Photocatalysts and electrocatalysts have the potential to address some of our current energy and environmental challenges. Driven by light or electricity, these catalysts have been studied for their ability to initiate reactions, such as producing hydrogen from water, converting CO_2 into molecules that have value, or breaking down pollutant molecules. An effective catalyst should have high activity, selectivity and accessible surface area, be stable and function under practical conditions. Additionally, the abundance and non-toxicity of the material should be a key consideration.

This presentation will include examples of different materials my research group have studied for photocatalytic or electrocatalytic chemical reactions.[1-5] In some cases, density functional theory guides the material design, or machine learning is used to discover the materials, such as perovskites or carbon nitride, that have promise as photocatalysts. These materials have been synthesised and following characterisation and testing, shown performance that has matched the prediction. We are also participating in the ARC Centre of Excellence for GETCO2, which is focused on electrochemical CO_2 reduction. This Centre includes academics from across Australia, along with partners from industry and overseas. I will give a brief overview of the Centre and our research.

This work was supported by Australian Research Council Discovery Projects (DP180103815 and DP220100945) and Centre of Excellence for GETCO2 (CE230100017).

Keywords: electrocatalysis, photocatalysis, pollutant, hydrogen, carbon dioxide

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Biography



Following her PhD (Chemistry) at The University of Melbourne, Rachel worked at the Hahn Meitner Institute (Berlin) and the Max Planck Institute of Colloids and Interfaces (Potsdam) before returning to The University of Melbourne, where she held ARC-funded research fellowships and worked (50%) at CSIRO. She is now a Distinguished Professor at RMIT in Applied Chemistry and Environmental Science and Deputy Director of an ARC Centre of Excellence on Green Electrochemical Transformation of Carbon Dioxide. Her research group investigates approaches to control the morphology and composition of inorganic materials for photocatalysis, electrocatalysis, photovoltaics and batteries.

Dr. Fan Fang
The University of Sydney

Day 1: 11:10-11:25; Invited Talk

Title: Ordered mesoporous SrTiO3 nanotubes: from structural engineering to active-site regulation

Abstract: Integrating crystalline order, hierarchical porosity, and well-defined active sites within a material remains a key challenge in heterogeneous catalysis. Here, we present ordered mesoporous $SrTiO_3$ nanotubes as a versatile platform for coupling structural engineering with active-site regulation across photocatalytic and thermal catalytic processes.

The nanotubular framework combines high crystallinity with interconnected mesopores, enabling efficient mass and energy transport while providing a robust architecture for tailoring catalytic sites. For photocatalytic CO_2 reduction, supported Cu–Pd alloys regulate intermediate adsorption and promote CO_2 activation, enabling efficient and selective CO production.[1] In thermal soot oxidation, K incorporation modulates defect-charge distribution and oxygen vacancies, facilitating oxygen activation, storage, and transfer.[2] More recently, chemical anchoring and geometric confinement within the mesoporous framework stabilize ultrafine $AgPd_1$ single-atom alloys against high-temperature aggregation, while adjacent Pd–Ag sites enable cooperative activation of NO and O_2 toward NO_2 formation.[3]

Together, these studies demonstrate how ordered mesoporous $SrTiO_3$ nanotubes integrate hierarchical transport, defect chemistry, and atomic-scale active-site engineering within a unified platform, offering a general strategy for designing advanced catalysts for energy and environmental applications.

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Biography



Dr. Fan Fang is an ARC DECRA Fellow in the School of Chemical and Biomolecular Engineering at the University of Sydney. His research focuses on heterogeneous catalysis, synchrotron-based characterizations and sustainable fuel synthesis. He has published over 20 peer-reviewed articles as first author or corresponding author in Angew, AIChE Journal, ACS Catalysis, Advanced Functional Materials etc.

Dr. Juan Bai
Queensland University of Technology, Australia

Day 1: 11:25-11:40; Invited Talk

Title: Tailoring Defective Molybdenum Centers for Enhanced and Durable Oxygen Evolution

Abstract: Electrocatalytic performance in the oxygen evolution reaction (OER) is generally dictated by the nature of intrinsic active sites within a catalyst. However, in certain oxide systems, high-valence metal centers—such as those present in molybdenum oxides—do not necessarily function as the true catalytic sites, largely due to their unfavorable adsorption toward reaction intermediates. To illustrate this, molybdenum oxide was selected as a model system, in which the native Mo centers are intrinsically inactive. By introducing phosphorus through defect engineering, these otherwise inert molybdenum sites can be reconfigured into cooperative active centers, thereby promoting OER activity. Systematic comparisons reveal that catalytic performance is closely linked to the synergistic effects between phosphorus incorporation and the formation of Mo/O vacancies. The optimized catalyst delivers an overpotential of 287 mV at 10 mA cm^{-2} and demonstrates excellent durability, with only ~2% activity loss after 50 hours of continuous operation. This work offers new perspectives on activating inert metal sites within oxide matrices, providing a viable strategy to increase the density of active centers and enhance electrocatalytic efficiency.

Maheshika Perera

Queensland University of Technology, Australia

Day 1: 11:45-12:00; Oral Talk

Title: Electrode Pairing of Plasma-Treated Fe Oxide/Pt and Co Oxide/Pt Nanosheets on Nickel Foam for Alkaline Overall Water Splitting

Abstract: Cost-effective, efficient, and durable electrocatalysts are essential for advancing green hydrogen production. Bifunctional materials, which can drive both the oxygen and hydrogen evolution reactions, are especially valuable here, since they help electrodes withstand the reverse-current stresses caused by intermittent renewable power.[1] Our group recently developed plasma-treated Fe_2O_3/Pt and Co_3O_4/Pt nanosheets on nickel foam, both of which performed well individually and as bifunctional catalysts.[2][3]However, bifunctional electrocatalysts are conventionally evaluated symmetrically, overlooking whether pairing two distinct, individually optimised catalysts as anode and cathode could yield superior overall performance.This work systematically investigates four electrode pairings built from these two catalysts in a two-electrode H-cell separated by an AGFA Zirfon membrane in 1 M KOH, benchmarked against bare nickel foam. At 10 mA cm^{-2}, the asymmetric pairing with Fe_2O_3/Pt as the anode and Co_3O_4/Pt as the cathode achieved the lowest cell voltage of all systems tested (1.54 V), followed by the symmetric Fe_2O_3Pt pairing (1.57 V), the reverse asymmetric pairing with Co_3O_4/Pt as the anode (1.61 V), and the symmetric Co_3O_4/Pt pairing (1.64 V). Electrochemical impedance spectroscopy supports this trend, with the best-performing pairing showing the smallest charge transfer resistance. This indicates anode identity, rather than cathode identity, is the dominant factor governing overall cell voltage. This work extends this comparison to 200-hour chronopotentiometry for all four systems to assess degradation under sustained operation. Post-stability SEM and EDX of both electrodes and the Zirfon membrane will determine whether iron species migrate from the Fe_2O_3/Pt anode across the membrane to the cathode, establishing whether asymmetric pairing offers a durable advantage or introduces new degradation pathways.

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Room #5: Low-Energy Devices 1

Prof. Xiaolin Wang
University of Wollongong, Australia

Day 1: 10:50-11:10; Keynote Talk

Title: **Novel Quantum Materials and Devices for Next-Generation Energy and Electronic Technologies**

Abstract: Quantum materials are creating new opportunities for transformative advances in energy-efficient electronics, quantum technologies, and energy conversion. I will highlight recent developments in novel quantum materials exhibiting unconventional electronic, magnetic, topological, and superconducting phenomena, with particular emphasis on their potential for ultra-low-energy electronic devices. I will also discuss emerging physical effects in liquid metals that offer new possibilities for soft and adaptive electronics. Recent progress in new classes of superconductors and superconducting diode effects will be presented, together with our perspective on the rapidly evolving quantum landscape of superconducting diodes, including their fundamental mechanisms, diverse material platforms, and opportunities for realizing non-reciprocal and energy-efficient quantum devices.

Assoc. Prof. Jin Zhang
University of New South Wales, Australia

Day 1: 11:10-11:30; Keynote Talk

Title: Toward Humidity-Tolerant Triboelectric Nanogenerators for Reliable Energy Harvesting

Abstract: Wearable triboelectric nanogenerators (TENGs) offer a promising route toward self-powered health monitoring, yet their performance at the skin/device interface is often compromised by ambient humidity and perspiration. Here, we present two complementary material strategies that transform moisture from a degradation factor into a functional advantage. First, a printable approach leverages ambient humidity through polar hydrophilic networks fabricated via liquid crystal display (LCD) 3D printing. Photocopolymerization of acrylic acid (AA), 2-hydroxyethyl acrylate (HEA), and N-hydroxyethyl acrylamide (HEAA) with polyethylene glycol diacrylate (PEGDA) produces micrometre-thin films enriched with ─COOH, ─OH, and ─CONH─ groups, which immobilize water molecules via hydrogen bonding to form a stable interfacial polarization tribolayer. Optimizing the HEAA:PEGDA ratio and incorporating 5 wt.% sulfobetaine methacrylate (SBMA) enhances dipole density, achieving outputs up to 45.6 μA, 802 V, and 48.4 W m^{-2} at 90% relative humidity. Complementarily, we develop a dielectric-engineered Janus nanofiber TENG that integrates unidirectional moisture transport with asymmetric fiber architectures. A bilayer system comprising a PVDF-HFP nanocomposite fiber layer embedded with barium zirconate titanate–silver (BZT–Ag) nanoparticles and a polyurethane (PU) layer enables rapid moisture expulsion within 4 s via surface-energy gradients and capillary transport. With optimized nanoparticle loading (7.5 wt.%) and a 3:1 PU:PVDF-HFP thickness ratio, the system delivers stable outputs of 17 W m^{-2}. These material innovations enable versatile wearable implementations, including motion-powered sensors and intelligent systems. A heel-mounted plantar sensor integrated with Bluetooth electronics and deep learning achieves 95% sensitivity and 91% specificity for fall detection, while a TENG-powered backscatter system demonstrates wireless energy transmission for implantable devices. Together, these approaches provide a robust platform for humidity-adaptive, self-powered wearable electronics.



Jin Zhang is a Scientia Associate Professor and Australian Research Council Future Fellow at the University of New South Wales, Sydney. Her research is centered on advanced fibers, composites, and biodegradable polymer materials, creating innovative multifunctional systems for energy, sensing, lightweight engineering, self-cleaning surfaces, and healthcare applications. She was awarded an Endeavour Fellowship in 2012 and a Victoria Fellowship in 2013. Professor Zhang currently leads several major Australian Government funded initiatives, including an ARC Future Fellowship, ARC Linkage Projects, and CRC-P projects. Her work advances sustainable materials, energy solutions, and innovative technologies with strong industry and societal impact and global relevance.

Prof. Katsuhiro Tomioka
Hokkaido University, Japan

Day 1: 11:30-11:45; Invited Talk

Title: Vertical III-V Nanowire Multi-Mode Transistor for Ultra-Low-Power Circuit Applications

Abstract: Large-scale integration (LSI) technology faces difficult challenges in suppressing power consumption and heat dissipation. The reason for the power and thermal bottlenecks originates from the theoretical limit of conventional FETs, for which no critical solution currently exists. The switching current in FETs involves thermionic transport mechanism, which limits minimum subthreshold slope (SS) of 60 mV/decade at room temperature. This theoretical limit in SS inevitably leads to a substantial increase in power consumption as integration density scales up because the supply voltage of each FETs is proportional to the SS. A fundamental strategy to address this issue is to realize a non-thermionic switching mechanism capable of achieving a steep SS. A breakthrough to a steep SS of 20 mV/decade would enable a reduction of the supply voltage to one-third of conventional FETs. Ultimately, this approach has the potential to reduce total power consumption in LSI by over 90% as compared to the LSI. With this regard, III-V nanowires (NWs) are promising candidates for channel materials for next-generation FETs. We have demonstrated vertical gate-all-around (VGAA) FETs [1] and tunnel FETs (TFETs) with steep SS by using modulation-doped III-V NWs/Si tunnel junctions by selective-area growth (SAG) [2]. In the SAG of III-V NWs, multiple electrodes can be integrated by utilizing metal composite mask. This approach enables the demonstration of VGAA multi-mode transistors that leverage distinct transistor modes. In this talk, we report on recent progress in the III-V NWs on Si using metal composite masks, and demonstrate VGAA multi-mode transistors exhibiting novel functionalities, specifically a threshold voltage-shift and a self-recovering phenomenon. And we will discuss our prospects for ultra-low power vertical circuits.

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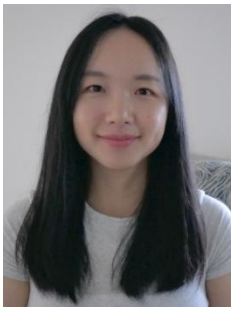
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Dr. Qianqian Shi
The University of Newcastle, Australia

Day 1: 11:45-12:00; Invited Talk

Title: 2D Soft Plasmonic Nanostructures for Energy Conversion and Sensing

Abstract: Natural leaves are flexible two-dimensional (2D) systems that efficiently harvest light energy and convert it into chemical energy, playing a vital role in maintaining Earth's ecological balance. Learning from the unique structures and functions of natural leaves provides important inspiration for developing soft 2D photocatalysts with structural flexibility and environmental adaptability for solar energy conversion. However, most current artificial photosynthesis systems are either solution-based or supported on rigid substrates. These systems often suffer from challenges such as nanoparticle aggregation, limited adaptability to dynamic environments, and reduced contact between reactants and catalysts due to the compact and entangled arrangement of photocatalysts on solid supports. To address these challenges, I developed a self-assembly strategy to fabricate photocatalysts with leaf-like structures and functions. In this talk, I will introduce how soft, flexible 2D plasmonic nanoassemblies with integrated optical and electrical functionalities can serve as artificial leaves for solar energy conversion, and how their nanoscale structure and composition can be precisely engineered to meet diverse application requirements. Beyond energy conversion, I will also discuss how coupling nanoscale structural programmability with collective plasmonic interactions gives rise to distinctive mechanical and optical properties, enabling their applications in chemical sensing, and electrocatalysis.



Biography: Dr Qianqian Shi received her Ph.D. in Chemical Engineering at Monash University in 2018. In 2020, she was awarded the ARC DECRA Fellowship. In 2024, she joined the Discipline of Chemistry at the University of Newcastle as a lecturer. Her research focuses on the design and fabrication of functional plasmonic nanomaterials for applications in sensing, photonics, and energy converstion, with a particular emphasis on integrating mechanical softness into plasmonic systems to unlock new functionalities enabled by structural flexibility. Dr Shi has published more than 50 peer-reviewed papers in leading materials, physics, and chemistry journals, with >3,400 citations.

Prof. Guoxiu Wang
University of Technology Sydney, Australia

Day 1: 13:00-13:35; Plenary Talk

Title: Materials Innovation for Green Hydrogen Production and High-performance Batteries

Abstract: Global warming and climate change are the biggest challenges facing humanity in the 21st century. My centre mainly focuses on developing efficient energy devices for sustainable energy production, storage, and conversion. In this talk, I will briefly introduce my team's achievements in several key sustainable energy technologies through rational materials design and innovative materials synthesis. These include (i) Electrochemical catalysts for green hydrogen production[1,2]. Single-atom catalysts offer a pathway to cost-efficient catalysis with minimal precious-metal use, but creating and maintaining them is challenging. Double transition-metal MXene nanosheets, $Mo_2TiC_2T_x$ were fabricated with abundant exposed basal planes and Mo vacancies in the outer layers by electrochemical exfoliation. The developed catalyst exhibits an outstanding catalytic ability with a low overpotential and a mass activity about 40 times greater than the commercial platinum-on-carbon catalyst; (ii) Lithium-ion and lithium-air batteries for electrification of road transport, such as electric vehicles[3-5]. I will report a recent development on an ionic liquid bearing the redox-active 2,2,6,6-tetramethyl-1-piperidinyloxy moiety, which serves multiple functions as a redox mediator, oxygen shuttle, lithium anode protector, and electrolyte solvent. The additive contributes a 33-fold increase in the discharge capacity in comparison to a pure ether-based electrolyte; (iii) Low-cost rechargeable batteries for grid-scale renewable energy[6,7]. Sodium-based batteries and zinc-ion batteries are considered a promising system for low-cost stationary energy storage and conversion, owing to the natural abundance of sodium. Several electrode materials were synthesised for sodium-sulphur batteries and aqueous zinc-ion batteries; (iv) Rational design of electrolyte systems for improving the safety of high-energy batteries[8,9]; and (v) Facile and sustainable recycling of spent lithium-ion batteries[10].

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Guoxiu Wang is the Director of the Centre for Clean Energy Technology and a Distinguished Professor at the University of Technology Sydney (UTS), Australia. Professor Wang is an expert in materials chemistry, electrochemistry, energy storage and conversion, and battery technologies. Currently, he serves as an Associate Editor for Electrochemical Energy Reviews (Springer-Nature) and an Associate Editor for Energy Storage Materials (Elsevier). His research interests include lithium-ion batteries, lithium-air batteries, sodium-ion batteries, lithium-sulfur batteries, CO_2 conversion, and electrocatalysis for hydrogen production. Professor Wang has published more than 800 refereed journal papers. His publications have attracted more than 105,000 citations, with an h-index of 177 (Google Scholar). He has been recognised as a highly cited researcher in Materials Science and Chemistry by Web of Science/Clarivate Analytics. Professor Wang is an elected Fellow of the Australian Academy of Science (FAA) and Fellow of the Australian Academy of Technological Sciences & Engineering (FTSE). Professor Wang is an Australian Research Council (ARC) Industry Laureate Fellow.

Prof. Maria Antonietta Loi
University of Groningen, Netherlands

Day 1: 13:35-14:10; Plenary Talk

Title: Sn-Pb metal halide perovskites challenges and opportunities for photovoltaics

Abstract: Mixed Tin-Lead (Sn-Pb) perovskites have the potential to achieve higher performance in single-junction solar cells compared to Pb-based compounds. However, the current power conversion efficiencies lag far behind those of pure Pb-based perovskite devices. Interfaces are most likely the reason for the large difference in performance. Nowadays, the most commonly used hole transport layer (HTL) for Sn-Pb-based perovskite solar cells is PEDOT:PSS, even though there are concerns about its potentially detrimental role in the performance and long-term stability of the active layer. Recently, we have shown that a self-assembled monolayer of [2-(3,6-dibromo-9H-carbazol-9-yl)ethyl]phosphonic acid (Br-2PACz) offers significant advantages when used as the HTL in solar cells with an active layer of $Cs_{0.25}FA_{0.75}Sn_{0.5}Pb_{0.5}I_3$ [1]. Several factors appear to contribute to the improved performance compared to devices using PEDOT:PSS as the HTL: the perovskite layer deposited on SAMs exhibits higher crystallinity, with reduced pinhole density, larger grains, and a lower defect density at the buried interface. We further investigate the entire halogenated family of PACz molecules, devices with outstanding stability both in the dark and under illumination were obtained[2]. Building on the buried interface passivation, we further investigated the passivation of the top surface, achieving devices with power conversion efficiencies above 25% [3]. A discussion about the physical and chemical mechanisms behind the passivation will be provided.

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Maria Antonietta Loi earned her PhD in physics from the University of Cagliari in 2001. She began her career as a postdoctoral fellow at the Linz Institute for Organic Solar Cells and later worked at the Institute for Nanostructured Materials in Bologna. In 2006, she joined the University of Groningen as an assistant professor and Rosalind Franklin Fellow, where she now serves as a full professor and chairs the Photophysics and OptoElectronics group.

With over 300 peer-reviewed publications, she is a expert in photophysics and optoelectronics. Her accolades include ERC Starting (2013) and Advanced (2022) Grants, the Physicaprijs (2018), and fellowships from the APS, KNAW, EURASC, Royal Society of Chemistry, MRS, and Leopoldina. She serves as Editor-in-Chief of *Applied Physics Letters*.

Room #1: Catalyst 2A

Prof. Yao Zheng
Adelaide University, Australia

Day 1: 14:20-14:40; Keynote Talk

Title: Proton's Behaviors in Water Electrolysis

Abstract: During water electrolysis, protons serve not only as charge carriers but also play a central role in interfacial reaction and transport processes. At the anode, water oxidation generates oxygen together with a large flux of protons, which must be rapidly removed through the highly confined electrochemical interface under strong electric fields. Proton transport relies on cooperative migration through hydrogen-bonded water networks and ionomer transport channels. Their local concentration and transport kinetics directly regulate reaction rates, interfacial acid–base environments, and catalyst structural stability. Proton accumulation at the catalyst surface or within the lattice can induce proton insertion, lattice distortion, and surface reconstruction, accelerating catalyst degradation. In contrast, efficient and ordered proton transport preserves catalyst integrity and enhances both electrolyzer efficiency and long-term durability. At the cathode, proton transport governs the kinetics of the hydrogen evolution reaction. Protons are enriched at the interface through solvated water molecules and ionomer pathways before coupling with electrons to form adsorbed hydrogen intermediates. Local proton availability, transport resistance, and interfacial water structure determine intermediate coverage and reaction energy barriers. This report systematically investigates these microscopic proton transport processes and elucidates how they govern the macroscopic performance, efficiency, and durability of water electrolysis systems.



Yao Zheng received his PhD degree in 2014 with Prof. Shizhang Qiao from University of Queensland. Currently, he is a Professor in the School of Chemical Engineering in the Adelaide University. His research focuses on electrocatalysis especially green hydrogen generation from (sea)water, including fundamentals understanding, electrocatalysts design, and electrolyzer device development

Prof. Guohua Jia
Curtin University, Australia

Day 1: 14:40-15:00; Keynote Talk

Title: Thermally Reversible Interconversion between Two Isomeric Forms of Silver Sulfide Magic-Size Clusters

Abstract: Isomers of semiconductor magic-size clusters (MSCs) share the same molecular formula but can exhibit distinct optical and electronic properties. Most of the reported MSC isomers have been so far limited to cadmium chalcogenides. Herein, we report the reversible transformation between two Ag_2S MSC isomers synthesized in solution under mild reaction conditions. These MSC isomers, which we denote as MSC–356 and MSC–306 according to their characteristic excitonic peaks in their absorption spectra (356 and 306 nm, respectively), share the same structural formula $(Ag_2S)_{10}(HSCH_2CH_2COOH)_{10}(HOCH_2CH_2OH)_{16}$ determined by time of flight mass spectrometry, Fourier transform infrared spectroscopy, thermogravimetric analysis, differential scanning calorimetry and inductively coupled plasma optical emission spectrometry. Reversible transformation between these two isomers is thermally induced. The isomerization from MSC–356 to MSC–306 follows the first-order kinetics with an activation energy of 233 kJ mol^{-1}. It occurs within a narrow temperature window of 54–66 °C, with lower temperatures resulting in significant delays in the transition, while the reverse conversion from MSC-306 back to MSC-356 requires a significantly higher temperature of 110 °C. These two isomers also display different energy band structures and electronic properties, with MSC–306 possessing a slightly smaller work function (3.85 eV) than MSC–356 (3.92 eV); the former also shows better catalytic performance in the hydrogen evolution reaction. The synthetic strategy reported here enables the synthesis of environmentally benign silver chalcogenide MSC isomers and provides important insights into their growth mechanisms and nanoscale structure–property relationship.

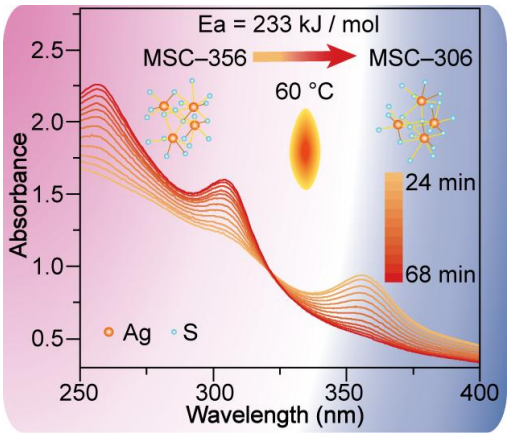


Figure 1. Two isomers of Ag_2S magic-size clusters, MSC–356 and MSC–306, undergo a reversible interconversion under thermal stimuli.

[1] W. Fan, S.u Jia, Y. Zhou, X. Tong, B. Bai, C. Zhan, D. Sun, A. L. Rogach, G. Jia, under review.



Dr. Guohua Jia is a Professor and Future Fellow at Curtin University. His research mainly focuses on the chemistry and physics of colloidal nanocrystals, with particular emphasis on their shape-dependent properties and applications in lighting and displays and catalysis. He is an elected Fellow of the Royal Society of Chemistry (FRSC) and the Royal Australian Chemical Institute (FRACI), and serves as the Chair of the RACI Materials Chemistry Division. He is the Editor of Materials & Design (Elsevier), Materials Today Chemistry (Elsevier), Journal of Information Display (Taylor & Francis), and Australian Journal of Chemistry (CSIRO), and an advisory board member for six journals.

Dr. Doudou Zhang
Macquarie University, Australia

Day 1: 15:00-15:15; Invited Talk

Title: Magnetron Sputtered Ultrathin Boron Nitride Enables Highly Selective Solar-Driven Nitrite-to-Ammonia Conversion

Abstract: Photoelectrochemical (PEC) nitrogen conversion offers a sustainable route for simultaneously remediating nitrogen-containing wastewater and producing green ammonia under solar illumination. Among various nitrogen species, nitrite (NO_2^-) possesses lower thermodynamic and kinetic barriers than nitrate, making it an attractive feedstock for efficient solar-driven ammonia synthesis. However, rapid interfacial charge recombination, competing hydrogen evolution, and poor semiconductor stability remain major challenges that limit conversion efficiency and NH_3 selectivity. In this talk, we report a TiOx/BN/InP photocathode incorporating an ultrathin amorphous boron nitride (BN) interlayer to regulate charge transport and interfacial reaction kinetics for highly selective PEC nitrite reduction. The BN interlayer effectively passivates surface defects, suppresses carrier recombination, and promotes directional electron transfer from the InP absorber to the TiO_x catalytic layer through quantum tunnelling, while maintaining excellent chemical stability. This synergistic interface engineering significantly enhances photovoltage and charge separation, resulting in nearly quantitative ammonia selectivity with a Faradaic efficiency approaching 100% under simulated solar illumination at 0 V versus the reversible hydrogen electrode. Mechanistic investigations reveal that the BN interlayer not only accelerates carrier extraction but also modifies the semiconductor–electrolyte interface, facilitating nitrite adsorption and suppressing the competing hydrogen evolution reaction. The improved interfacial kinetics lead to stable and efficient solar-assisted ammonia production. The proposed interface engineering concept provides new opportunities for coupling wastewater remediation with renewable ammonia production and offers a general design principle for next-generation photoelectrochemical solar fuel systems.

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Dr. Doudou Zhang is an outstanding early-career researcher, leading an independent SunCatFuels Group in the School of Engineering. Her group focused on (photo)electrochemical materials, scalable device fabrication, and renewable energy technologies. Prior to joining Macquarie University, she worked at Australian National University for five years on solar-to-hydrogen technologies and contributed world-leading solar-to-hydrogen efficiencies. Dr. Zhang has published over 40 peer-reviewed papers, one book chapter. She has secured more than A$2 million in competitive funding as Lead or Co-Investigator, including an ARC Discovery Project, ARENA-supported hydrogen commercialisation projects, and major research infrastructure grants.

Dr. Xiaocheng Liu

Institute of Metal Research Chinese Academy of Sciences, China

Day 1: 15:15-15:30

Title: JMST: A Platform for High-Impact Research in Materials Science

Abstract: The rapid development of materials science is creating new opportunities for addressing major challenges in energy, sustainability, advanced manufacturing, and emerging technologies. As a leading international journal in materials science and metallurgy, the *Journal of Materials Science & Technology* (JMST) provides a platform for disseminating cutting-edge discoveries and promoting high-impact research across the broad materials community. This presentation introduces the development, scope, and recent progress of JMST, with particular emphasis on emerging research trends and their scientific impact. The journal covers a wide range of rapidly developing fields, including energy-storage materials, catalysis, nanomaterials, high- and medium-entropy materials, advanced alloys, biomaterials, electronic materials, and additive manufacturing. Recent publication trends demonstrate increasing research activity in several of these areas and reflect the evolving priorities of the international materials community. JMST has experienced substantial growth in both submissions and scientific influence. In 2025, the journal received 11,388 submissions worldwide and published more than 900 articles, with contributions spanning over 50 countries and regions. Its growing international visibility is further demonstrated by an impact factor of 16.8 and increasing recognition of JMST publications by leading multidisciplinary journals. A rigorous editorial and peer-review process, supported by an international editorial team and materials experts, ensures the scientific quality and originality of published work. By highlighting emerging research directions, influential scientific achievements, and JMST's global publication platform, this presentation aims to provide insights into current trends in materials science and opportunities for communicating high-impact research to the international community.



Xiaocheng Liu

Editor, Journal of Materials Science & Technology

Division of Journals & Information, Institute of Metal Research, Chinese Academy of Sciences

Room #2: Solar 2

Prof. Mats R. Andersson
Flinders University, Australia

Day 1: 14:20-14:40, Keynote Talk

Title: Thermally robust organic photovoltaic devices based on a low content of amorphous donor polymers

Abstract: Polymer solar cells have gained considerable interest over the last few decades as a low-cost, environmentally friendly, lightweight, and flexible alternative to traditional photovoltaics. In recent years, photovoltaic performance has increased rapidly, with high power conversion efficiency for lab-scale devices. This work focuses on the design and synthesis of new conjugated polymers, as well as the thermal stability of polymer solar cells. Thermally stable materials are important for stable solar cells, as solar cells are often exposed to elevated temperatures during fabrication and use. Our work includes device stability measurements and morphology stability studies using dynamic mechanical thermal analysis (DMA). The DMA technique is a highly sensitive method for determining the thermal transitions of the used materials. Several completely amorphous indacenodithiophene-based polymers with varying side chains were synthesised and used in solar cells combined with the Y6 acceptor material. Low donor:acceptor (D:A) ratios are generally believed to yield lower efficiency than the more conventional 1:1.2 ratio. However, several of the solar cells exhibit a peak performance over 11% PCE at a lower D:A ratio.[1] Unexpectedly, as the polymer proportion increases, a reduced photovoltaic performance is observed. Importantly, our recent experiments also show that the thermal stability of the solar cells at 85 ^{o}C is significantly improved for a low donor:acceptor ratio (1:10), outperforming commercial high-performance polymer systems in efficiency after 30 days of stability measurements.[2]

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Prof. Zhijun Ning
Shanghai Tech University

Day 1: 14:40-15:00, Keynote Talk

Title: Perovskite Solar Cells Based on Metal-ion-linked Self-Assembled Monolayer (MiLSAM)

Abstract: In recent years, self-assembled monolayers as hole-selective contact layers have advanced the efficiency of inverted perovskite solar cells. However, their non-uniform coverage on metal oxide electrodes can lead to interfacial carrier recombination, a problem that is particularly pronounced in large-area devices. Meanwhile, the tendency of these molecules to desorb under photothermal stress also affects the operational stability of the devices. In this study, we introduce a metal-ion-crosslinked self-assembled molecular layer as a robust hole-selective contact layer to address these challenges. Through an alternating assembly method, a molecular network was constructed using high-valence metal ions as crosslinking nodes. The resulting metal-ion-crosslinked self-assembled molecular layer not only achieved uniform substrate coverage but also exhibited enhanced stability against surface reconstruction. Inverted perovskite solar cells employing this molecular layer achieved a power conversion efficiency of 26.71% with a certified efficiency of 26.46%, while 1 cm^2 devices delivered a record efficiency of 25.75%. Encapsulated devices based on this strategy demonstrated excellent thermal stability: they retained 91% of their initial efficiency after 2,000 hours under conditions close to ISOS-D-3 testing conditions (85°C, 85% relative humidity), and retained 90% of their initial efficiency after 1,000 hours of maximum power point tracking under conditions close to ISOS-L-3 testing conditions (85°C, 50% relative humidity). This work provides a viable pathway for simultaneously enhancing the stability and efficiency of perovskite solar cells.

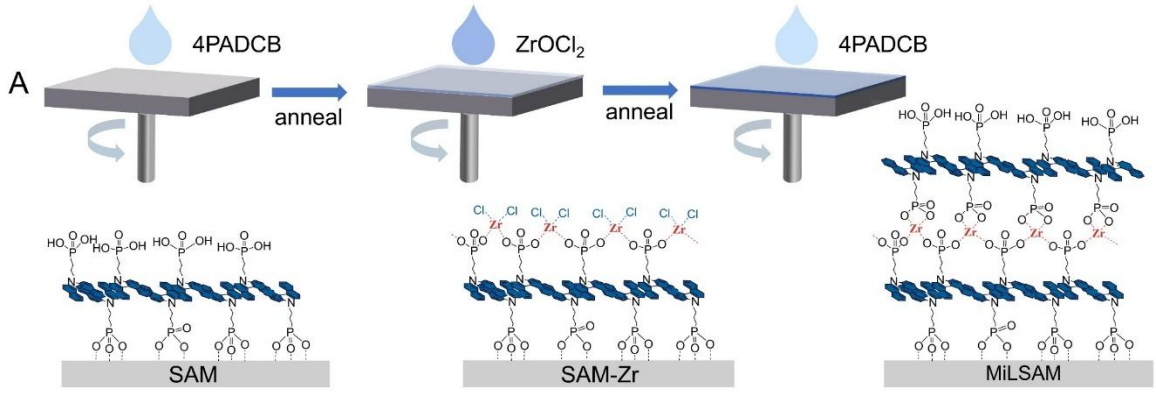


Fig. 1 Schematic of MiLSAM

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Dr. Meng Zhang
University of New South Wales, Australia

Day 1: 15:00-15:15, Invited Talk

Title: Crystallization Engineering of Wide Bandgap Perovskite Thin Films for Photovoltaic Applications

Abstract: Metal halide perovskites have emerged as one of the most promising candidates for next-generation photovoltaics. In particular, wide-bandgap perovskites hold great potential for applications in perovskite/silicon tandem solar cells. However, achieving high-quality wide-bandgap perovskite films with reliable processing remains challenging, especially under ambient conditions. In this talk, I will discuss our recent advances in controlling the crystallization process of metal halide perovskites for photovoltaic applications. Through systematic investigation of the crystallization pathway of narrow-bandgap perovskites, we revealed that the regulation of intermediate phases plays a critical role in determining the final film quality and defines the processing requirements for high-performance devices. Based on this understanding, we further extended the crystallization control strategy to wide-bandgap perovskites, enabling the reliable fabrication of high-quality films under ambient conditions. As a result, wide-bandgap perovskite solar cells prepared in air achieved a certified efficiency of 23.0%. Beyond intermediate phase regulation, we further explored the impact of crystallographic orientation on the stability of perovskite devices. We found that two-dimensional passivation layers formed on the (111) crystal plane exhibit superior stability compared with those formed on the (100) plane, showing minimal degradation during the thermal lamination process of encapsulation. By engineering the crystallization process, highly (111)-oriented wide-bandgap perovskite films were successfully obtained, leading to devices with an efficiency of 23.3%. These findings highlight the importance of crystallization engineering, including phase evolution and crystal orientation control, for advancing efficient and stable perovskite photovoltaics.

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Dr. Meng Zhang is a Senior Lecturer in the School of Photovoltaic and Renewable Energy Engineering at the University of New South Wales (UNSW). He received his Ph.D. from the University of Queensland in 2016 and was promoted as professor in Southwest Petroleum University in 2019. He was awarded an ARC DECRA Fellowship in 2022. His research focuses on the fundamental science and engineering of metal halide perovskite materials and perovskite solar cells, with particular interests in phase evolution dynamics and scalable device fabrication.

Dr. Robert John Patterson
UNSW Sydney, Australia

Day 1: 15:15-15:30, Invited Talk

Title: The search for stable and scalable high-performance semiconductors for silicon tandem solar cells

Abstract: Silicon tandem solar cells have demonstrated outstanding certified efficiencies of over 30%, making them the next major innovation in photovoltaic research. However, the two major material systems used to make these high efficiency devices, III-V semiconductors and Pb-halide perovskites, suffer from severe scalability and stability problems respectively. This presentation will survey some of the emerging material systems that may show promise in applications in top cells for silicon tandem solar cells, if not in photovoltaic cells in their own right. Material systems of interest include oxide, sulfide and phosphide semiconductors, each of which have their own advantages and drawbacks. Findings on materials explored over the better part of the last decade at UNSW in the context of the criteria that are required to make outstanding scalable silicon tandems from stable materials will be discussed, from a perspective informed by both computational and experimental findings. The role that machine learning and artificial intelligence may play to accelerate computational materials discovery will be briefly outlined. Mass manufacturable silicon tandem solar cells that have lifetimes equivalent to conventional photovoltaic cells would provide numerous benefits including significant savings in the cost of the balance of systems for solar farms, reduced surface area required for gigawatt scale solar farms to improve land use and significantly reduced pressure on basic materials and supply chain constraints as the photovoltaic industry moves to terawatt scale.

Biography:



Rob Patterson is an applied physicist developing promising clean energy technologies including advanced photovoltaics, electrified low carbon liquid fuels production and industrial decarbonization. Originally educated in Canada, he joined UNSW Sydney in 2008 and has worked there in the School of Photovoltaic and Renewable Energy Engineering (SPREE) since then. He has over 20 years of experience in the field of solar energy, nanomaterials and quantum mechanical materials simulation (DFT). His recent work in solar energy focuses on new materials discovery, to find stable and scalable light harvesting semiconductors to use as top cells in silicon tandem photovoltaics.

Room #3: Catalyst 2B

Prof. Nadim Darwish
Curtin University, Australia

Day 1: 14:20-14:40, Keynote Talk

Title: Electrostatic Catalysis of the Azide–Alkyne Huisgen Cycloaddition

Abstract: External electric fields (EEFs) are emerging as a new class of catalysts for chemical reactions in the rapidly evolving field of electrostatic catalysis, with some of the most direct experimental demonstrations achieved using single-molecule junctions.[1, 2] Single-molecule junctions are particularly well suited to probing electrostatic catalysis because very large electric fields can be generated across nanometre-scale electrode gaps. Electron transport through the molecule is predominantly elastic over these short distances, generally without changing the molecular oxidation state, local heating, and competing electrochemical processes. Here, we investigate electrostatic catalysis of the azide–alkyne Huisgen cycloaddition across two complementary length scales, first at the single-molecule level and subsequently at macroscopic electrified semiconductor–electrolyte interfaces. We first study the reaction using scanning tunnelling microscope (STM) single-molecule junctions, where the intense electric field generated between the electrodes provides a means of probing the influence of field magnitude and orientation on formation of the triazole product. These experiments establish the azide–alkyne cycloaddition as a model reaction for investigating electric-field effects at the level of individual reacting molecules. We then translate this concept to the macroscale using electrified silicon (Si)–electrolyte interfaces. As a semiconductor, Si provides a particularly useful platform for separating electric-field effects from those arising from electric current. The reaction is performed in the dark under conditions where Si is depleted of majority carriers and essentially no Faradaic current flows, while reaction progress is subsequently quantified electrochemically upon illumination. Our results show that, unlike metallic electrodes, semiconducting Si provides additional control over electrostatic catalysis through the interplay between the externally applied potential and the intrinsic built-in electric field within the semiconductor. By exploiting the different space charge layers of n-type and p-type Si and their corresponding flat-band potentials, the magnitude and direction of the interfacial electric field can be tuned to either enhance or inhibit the reaction.

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Nadim Darwish is a Professor in the School of Molecular and Life Sciences at Curtin University. He completed his PhD at UNSW, followed by postdoctoral research at UNSW and a Marie Curie Fellowship at the University of Barcelona. He later held a DECRA, a Curtin Research Fellowship, and a Future Fellowship. Nadim has co-authored more than 120 refereed articles in nanotechnology, electrochemistry and materials chemistry. His research focuses on nanoscale characterization tools, including single-molecule electrical measurements. He is a Fellow of the Royal Australian Chemical Institute and has received the 2020 A.M. Bond Medal and the 2017 WA Young Tall Poppy Science Award.

Dr. Wenjie Tian
The University of Adelaide, Australia

Day 1: 14:40-15:00, Keynote Talk

Title: Engineering Carbon Nitride Interfaces for Solar-to-Chemical Conversion

Abstract: Solar-to-chemical conversion provides a promising route to transform abundant solar energy into fuels and value-added chemicals. Carbon nitride is an attractive photocatalytic platform because of its metal-free framework, tunable electronic structure, and suitable band positions. However, its performance is often limited by inefficient charge separation, insufficient surface reaction sites, and weak interfacial coupling with catalytic components. In our recent work, we have engineered a series of carbon nitride interfaces to enhance solar-driven conversion reactions. First, hierarchical carbon nitride-supported single-atom Fe catalysts are introduced for tandem microplastic degradation and hydrogen production.[1] The Fe–N_4 sites improve interfacial charge transfer and surface redox reactions, enabling the sufficient plastic waste reforming and coupled solar hydrogen generation. Second, a Spirulina-derived strategy is used to construct atomically dispersed Fe–N_4 sites on g-C_3N_4 for photocatalytic CO_2 reduction,[2] where the engineered Fe–N_4 interface promotes CO_2 activation and solar fuel formation. Finally, we also constructed C_3N_4-photosystem II biohybrid photoanodes as an extension of carbon nitride interface design for biohybrid solar conversion.[3] These studies show that carbon nitride interfaces can be tailored through single-atom sites, hierarchical structures, and biohybrid coupling to support different solar-to-chemical pathways. This work provides design principles for photocatalytic and photoelectrochemical systems for sustainable fuel and chemical production.

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A/Prof. Rahman Daiyan
UNSW Sydney, Sydney, Australia

Day 1: 15:00-15:15, Invited Talk

Title: Developing Nanomaterials and Electrolyser Systems for Power to X Applications

Abstract: Electrochemical approaches to closing both the carbon and nitrogen cycles have emerged as promising routes towards decarbonization of the world economy, and a shift towards energy sustainability and enabling a circular economy. The electrochemical reduction reaction of CO_2 (CO_2RR) and nitrates/nitrites (NO_xRR) powered with renewable electricity provides a pathway for simultaneously alleviating their release into the environment, whilst converting intermittent renewable energy to value-added and stable chemical commodities (through a renewable Power-to-X platform). Recently, simultaneous CO_2RR and NO_3RR has also been employed to synthesize C-N products such as urea, amines, and amides, demonstrating the capability to decarbonize fertilizer, fine chemicals, and pharmaceutical industries. Our research focuses on focuses on the design, synthesis, and application of highly active nanomaterials for various energy conversion reactions. For example, our transition metal and carbon-based single atom catalysts (SACs) exhibit low cost, minimal metal usage, and excellent activity facilitated by large surface areas and exposure of active sites. By modulating active sites and tuning co-ordination chemistry of these catalysts, we reveal structure-activity correlations and scaleup device performance for (i) tuning the electrochemical conversion of CO_2 to CO in acidic membrane electrode assembly electrolysers, (ii) developing kW stack NO_x abatement system and (iii) C-N coupling products such as urea, formamide and methylamine. Our research has subsequently led to two commercialisation ventures.

Biography: Dr. Rahman Daiyan is a renewable energy and powerfuel specialist with a track-record in nanomaterial and system development for energy conversion reactions. He is an Associate Professor and Scientia Fellow at the School of Minerals and Energy Resources Engineering at the University of New South Wales, and an ARC DECRA Fellow. He is deputy director of ARC Centre of Excellence in Carbon Science and Innovation, Chief Investigator at ARC Research Hub in Next Generation Mining, ARC Training Centre for Global Hydrogen Economy, ARC Centre of Excellence in Renewable Fuel. He is the deputy-director of NSW Government funded Powerfuels including hydrogen network, comprising 70 industry partners. He is the co-founder of two university spinout: OzAmmonia and Gurung Fuels.

Muhammad Hamza Nazir
RMIT University, Australia

Day 1: 15:15-15:27, Oral Talk

Title: Printed Liquid Metal–Solid Metal Hybrid Electrodes for Stabilizing Liquid Platinum–Gallium Droplets During Electrocatalysis

Abstract: Dispersing catalytically active gallium (Ga)-based liquid metal (LM) nano- and micro-droplets onto solid metallic mesh substrates remains challenging due to their strong tendency to either agglomerate or migrate away from the substrate. Another challenge is the reactivity of Ga with support metals, often forming discrete solid intermetallic phases. Here, we develop a 3D matrix formed by fused tungsten nanoparticles (W NPs) to physically entrap Ga-based LM nano-droplets, which effectively prevent their agglomeration and stabilize their reactive surface. Printing these W/LM composites onto a porous substrate (e.g., molybdenum (Mo) mesh) further promoted their dispersion and brought about enhanced electrochemical reactivity. To verify the efficiency of this strategy, we printed Pt-in-Ga droplets mixed with W NPs onto porous Mo substrate and evaluated their performance by two model reactions-CO2RR (CO2 reduction reaction) and HER (Hydrogen evolution reaction). The printed showed remarkable stability and reactivity toward both reactions. In addition, computational investigations revealed distinct active motifs for these two reactions, supporting the notion that adaptive LM catalysts can facilitate diverse reaction pathways depending on the targeted reactions.

Keywords: Liquid metals; printed electrodes; single atom electrocatalysis; CO2RR and HER catalysts

Room #3: Thermoelectric Materials 1

Prof. Zhi-Gang Chen

Queensland University of Technology, Australia

Day 1: 14:20-14:40, Keynote Talk

Title: Zero-emission thermoelectrics for solid-state power generation and cooling

Abstract: Climate change caused by the continuous accumulation of greenhouse gases is an imminent threat to mankind and biodiversity. Already a dry land with vulnerable biodiversity, Australia will be hard hit by climate change as evidenced by the recent natural disasters with much increased frequency and intensity. To stop climate change, we need to significantly reduce carbon dioxide (CO_2) to net-zero emissions. In this topic, we timely highlight the latest progress on the up-to-the-date thermoelectric devices with their unique designs and compelling thermoelectric efficiency for solid-state power generation and cooling, which will reduce our dependence on carbon-based energy sources. We carefully summarize the structure-related principles and factors that determine the performance of thermoelectric devices and propose strategies for improving their utilities. Besides, we focus on the timeliest designs for inorganic-based devices, organic-based devices, and hybrid-based devices targeting both power generation and cooling for zero-emission. Ultimately, we point out the current challenges, controversies, and prospects of thermoelectric devices.

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Biography: Zhi-Gang Chen is a Founding Director for ARC Research Hub in Zero-emission Power Generation for Carbon Neutrality, a Capacity Building Professor of Energy Materials, and ARC Future Fellow at Queensland University of Technology (QUT). He received his Ph.D. in materials science and engineering from the Institute of Metal Research, Chinese Academy of Science, in 2008. His research concentrates on smart functional materials for thermoelectrics and nanoelectronics from synthesizing materials to understanding their underlying physics and chemistry. As a lead Chief Investigator, Dr Chen has won over 50M research funding and published >560 peer-reviewed publications, including Science and Nature Sister journals, with >64,000 Google times and an H index of >136, >10 patents, and delivered over 100 plenary/keynote/invited talks. Prof. Chen is one of Clarivate Web of Science's highly cited researchers (2020-2022) and Elsevier Top 2% Scientist (2019-2026), Deputy Editor-in-Chief in Thermal Functional Materials (Springer), and associate editor in Journal of Materials Science and Technology (Elsevier), Exploration and Carbon Energy (Wiley).

Prof. Cheng-Liang Liu
National Taiwan University, Taiwan

Day 1: 14:40-15:00, Keynote Talk

Title: Organic/Hybrid Thermoelectric Materials and Devices

Abstract: Organic thermoelectric materials can directly transform the waste heat into electrical power without causing any pollution, but their development is limited due to poor performance, especially low conductivity. In my talk, we outline the design strategies which aim to develop high-performing organic semiconductors and their materials in organic thermoelectrics. A series of solution-processed organic semiconducting molecules are reported. These results indicate that these materials can be modulated through successive changes in conjugation length/side chain substituent length and molecular interaction based on a combination of molecular design and solution-processing techniques. Doping organic semiconductors, conjugated polymer composites, and gels with ionic salt or redox couples are used to achieve enhanced thermoelectric performance. Flexible/wearable thermoelectric generator based on these materials will be demonstrated.

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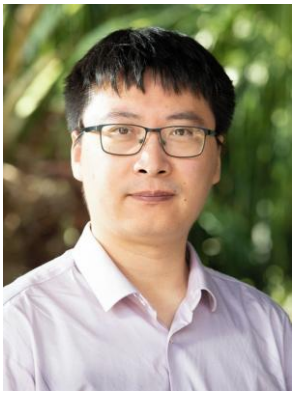
Cheng-Liang Liu is a Professor of Materials Science and Engineering at National Taiwan University. He received the B.S. and Ph.D. degrees in Chemical Engineering from National Taiwan University in 2002 and 2007, respectively. He then worked as visiting scientist at the University of Washington from 2005 to 2006, postdoctoral fellow at National Taiwan University from 2008 to 2010, Assistant Professor at Yamagata University (Japan) from 2010 to 2012, Assistant and Associate Professor at National Central University (Taiwan) from 2012 to 2020, before joining National Taiwan University in 2020. His research focuses on organic polymers and hybrid materials for electronic and energy applications, including transistors, memory devices, solar cells, and thermoelectric systems.

Dr. Xiaolei Shi
Queensland University of Technology, Australia

Day 1: 15:00-15:15, Invited Talk

Title: Flexible Thermoelectric Materials and Devices for Power Generation and Refrigeration

Abstract: Inorganic thermoelectric materials generally outperform their organic and carbon-based counterparts in thermoelectric performance, making them highly attractive for efficient energy conversion. However, their intrinsic brittleness remains a major obstacle to the development of flexible thermoelectric devices for wearable power generation, personal cooling, and other emerging applications. This report provides a comprehensive overview of our recent advances in the flexibilization of inorganic thermoelectric materials and devices. We summarize strategies that integrate structural engineering, compositional design, and scalable processing techniques to simultaneously achieve high mechanical flexibility and outstanding thermoelectric performance. Particular emphasis is placed on the underlying structure–property relationships and design principles that enable the coexistence of mechanical compliance and efficient charge and heat transport. Finally, we discuss the broad application potential of flexible inorganic thermoelectric materials and devices in wearable electronics, self-powered sensing, thermal management, and other next-generation energy technologies, together with the remaining challenges and future research opportunities.



Dr Xiaolei Shi is an ARC DECRA Fellow and Senior Lecturer at Queensland University of Technology (QUT), specializing in high-performance thermoelectric materials and devices. He has secured competitive funding through multiple ARC Discovery, Linkage, and Research Hub projects totalling over AUD 15.6 million. Recognized among Elsevier's Top 2% Scientists worldwide for five consecutive years (2021-2025), he has published over 300 papers, including articles in Science, Nature Sustainability, Chemical Reviews, and Advanced Materials. His publications have received more than 23,000 citations (H-index 82), and he was awarded QUT's 2024 Early or Mid-Career Researcher of the Year.

Dr Meng Li

Day 1: 15:15-15:30, Invited Talk

Title: Progress and opportunities in composite thermoelectric materials

Abstract: Composite thermoelectric materials offer opportunities to improve energy conversion and solid-state cooling through coordinated control of constituent phases and interfaces. This presentation highlights progress in transport modelling, interfacial engineering, mechanical optimisation, and functional integration. Drawing on our recent work, we discuss how phase morphology, connectivity, and interfacial interactions regulate electronic and thermal transport, and how composite design can enhance thermoelectric performance alongside strength and flexibility. Key challenges include predictive phase selection, quantitative understanding of interfacial transport, and translating material properties into reliable devices. Future opportunities lie in integrating machine-learning-assisted design, multiscale simulations, and advanced characterisation to accelerate composite development. Incorporating photovoltaic and magnetocaloric phases further opens routes to combined light and heat harvesting and hybrid cooling, extending composite thermoelectrics towards multifunctional energy-conversion and thermal-management systems.

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Biography: Meng Li received his PhD from The University of Queensland in 2022 and is currently a Research Fellow at Queensland University of Technology. His research interests include AI-driven materials discovery, integrated computational materials engineering, synchrotron and neutron characterisation, and functional materials, with a particular focus on thermoelectrics and quantum materials. He was awarded the ARC DECRA Fellowship in 2025.

Room #5: Low Energy Devices 2

Prof. Wenlong Cheng

The University of Sydney, Australia

Day 1: 14:20-14:40, Plenary Talk

Title: Nano-enabled Intelligent Soft Bioelectronics

Abstract: The rapid growth of telehealth, digital medicine, and the Internet of Things (IoT) is driving demand for wearable technologies capable of continuously monitoring physiological and biochemical biomarkers through wireless, smartphone-connected platforms. Achieving this requires soft, ultrathin, and stretchable sensing systems that conform intimately to biological tissues. Here, we have developed nano-engineered electronic skins and soft bioelectronic platforms that establish seamless biointerfaces with skin and organoids, enabling continuous, real-time, in situ physiological monitoring. Combined with wireless communication and smartphone integration, these technologies offer a promising route toward next-generation remote healthcare and personalized medicine.



Biography: Wenlong Cheng is a professor in the School of Biomedical Engineering at the University of Sydney. He is currently NHMRC Investigator Leadership Fellow and a fellow of Royal Society of Chemistry and was an Ambassador Tech Fellow in Melbourne Centre for Nanofabrication. He earned his PhD from Chinese Academy of Sciences in 2005 and his BS from Jilin University, China in 1999. He was Alexander von Humboldt fellow in the Max Planck Institute of Microstructure Physics and a research associate in the Department of Biological and Environmental Engineering of Cornell University. He founded Monash NanoBionics lab at the Monash University in 2010. His research interest lies at the Nano-Bio Interface, particularly self-assembly of 2D plasmonic nanomaterials, DNA nanotechnology, electronic skins and stretchable energy devices. He has published 260 papers. He is currently the scientific editor for Nanoscale Horizon (Royal Society of Chemistry) and the editorial board members for a few journals including Nanoscale, Nanoscale Horizons, Nanoscale Advances, Advanced Sensor Research, Advanced Electronic Materials, ChemNanomat, Advanced Sensors and Energy Materials, iScience, Chemosensors, and Austin Journal of Biomedical Engineering, FlexTech, Soft Science and Wearable Electronics.

Dr. Shuying Wu
The University of Sydney, Australia

Day 1: 14:40-15:00, Plenary Talk

Title: Advanced Conductive Polymer Nanocomposites for On-Skin Sensors/Electrodes

Abstract: On-skin sensors and electrodes are emerging as key enabling technologies for continuous physiological monitoring, human-machine interfaces, and soft robotics [1-3]. However, the development of high-performance on-skin electronics remains challenging. Conventional conductive materials often exhibit poor adhesion to skin, limited conformal contact, and unstable signal acquisition under motion, leading to increased interfacial impedance and motion artefacts. In addition, isotropic conductive networks within polymer matrices limit its capability in detecting directional force.

Herein, flexible and stretchable electromechanical sensors are developed based on conductive polymer nanocomposites via printing or solution casting. For the printed sensors, the substrate is made of sodium carboxymethyl cellulose (NaCMC) functionalized with glycerol to achieve high stretchability, while the ink is composed of silver nanowires (AgNWs) with NaCMC and glycerol as the binders, which not only contribute to overall environmental sustainability but also enable strong bonding with the substrate. The effects of material composition of both the ink and the substrate on printability, electrical conductivity, as well as mechanical and electromechanical properties were thoroughly examined [3]. In addition, the conductive inks have been used to create interdigital piezocapacitive sensors which demonstrate capability to detect motions in different directions.

Meanwhile, to enhance the long-term stability of the skin sensors/electrodes, we introduced self-adhesive capability by engineering material composition of a conductive polymer composites made of silver nanowire, PEDOT:PSS, poly(vinyl alcohol), and tannic acid. We utilized a data-driven composition optimization strategy integrating artificial neural network modeling and genetic algorithm to tailor the composites' properties for the application of sensors and/or electrodes, respectively. The potential of the developed sensors and electrodes in body motion detection, human-machine interface has been demonstrated.

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Dr. Shuying Wu is currently a Senior Lecturer and ARC Future Fellow in the School of Aerospace, Mechanical and Mechatronic Engineering (AMME), The University of Sydney. Before joining AMME in 2023, she was a Senior Lecturer at School of Engineering, Macquarie University (Oct 2018-Aug 2023), ARC DECRA Fellow at School of Mechanical and Manufacturing Engineering, UNSW (May 2017-Sep 2018), Research Fellow at School of Engineering, RMIT University (Apr 2014-Apr 2017) and Deakin University (Sep 2013-Mar 2014). Dr. Wu's research focuses on the design and development of functional polymer composites for diverse applications, including wearable electronics and lightweight aerospace structures.

Assoc. Prof. Soniya Yambem
Queensland University of Technology

Day 1: 15:00-15:15, Invited Talk

Title: Low voltage operating solid-state organic transistor sensors/biosensors

Abstract: Sensors and biosensors contribute significantly to improving the speed, accuracy, and accessibility of diagnostic and analytical processes across a wide range of fields, making them indispensable in modern science and technology. Organic transistors have attracted significant interestfor developing sensors and biosensors as they can amplify signals and can be functionalized to detect different analytes using selective components/membranes and intelligent device designs, making them highly suitable for sensing applications. Solution processable, as well as solid-state organic transistors are desirable because they can be fabricated with simple steps and can be easily integrated together for multiplexed sensing.[1]

In this talk, I will present our group's work which focuses on developing organic thin film transistors (OTFTs) for applications in sensors, biosensors and bioelectronics. [1-4] We specifically focus on solution processable solid-state OTFTs that operate at low voltages (<1V), exploiting organic semiconductors that can be processed at low temperatures and can be directly deposited into complex patterns using techniques such as inkjet printing. Low operational voltages are critical to prevent electrolysis of water when working with aqueous based analytes. The solid-state nature of our OTFTs enables multiplexed sensing. We demonstrated this by designing a multiplexed ion sensing chip capable of detecting multiple ions in artificial blood plasma.[4] We are actively working on developing different types of solution processable solid state OTFTs and designs to enhance performance in sensing and reusability.

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Dr. Soniya D. Yambem is an Associate Professor in the Faculty of Science at Queensland University of Technology (QUT), Australia. A physicist by training, she has a strong research background in organic electronic devices, spanning organic photovoltaics, OLEDs, and low-voltage organic transistors. She completed her Ph.D. at the University of Houston, USA, in 2011, where her thesis focused on organic photovoltaics, before undertaking postdoctoral research at the Centre for Organic Photonics & Electronics (COPE) at The University of Queensland. She joined QUT in 2015 as a Vice Chancellor's Research Fellow. Her current research focuses on developing solution-processable organic transistors, with particular emphasis on applications in sensing, biosensing and

Room#1 Catalyst 3

Prof. Jian Liu
Inner Mongolia University, Hohhot, China

Day 1: 15:50-16:10 pm, Keynote Talk

Title: Precise Structural Regulation of Functional Nanomaterials for Catalysis and Energy Storage

Abstract: Precise multiscale structural regulation of functional nanomaterials represents a core scientific challenge to breaking performance bottlenecks in electrocatalysis and electrochemical energy storage. Guided by the principle of full-scale precise structural engineering from atomic sites to mesoscale architectures, our group has established a multidimensional, customizable synthetic methodology for functional nanomaterials based on interfacial self-assembly and mesopore confinement chemistry.

For atomic-level precision catalysis, targeting the limitation that single active centers cannot well support synergistic multi-electron transfer reactions, we propose a confinement construction strategy for diatomic active sites with finely tuned coordination microenvironments. Atomically precise arrangement and strong electronic coupling of bimetallic active centers are achieved within a mesoporous carbon framework, and the synergistic electron transfer mechanism and reaction pathway modulation between dual sites are systematically revealed.

For mesostructured nanoreactor design, addressing the shortcomings of conventional symmetric nanoreactors such as limited mass transport and insufficient exposure of high-curvature active interfaces, we pioneer a solvent-driven dissolution-regrowth-migration (SDM) synthetic strategy to fabricate asymmetric carbon nanoreactors with a “mesoporous sphere–lamellar nanosheet” heterostructure in one pot. Multiscale simulations uncover that the asymmetric architecture enhances local mass diffusion and optimizes substrate adsorption energy barriers.

These works mentioned above build a synergistic design system from the two dimensions of regulating the intrinsic activity of atoms and enhancing the mesoscopic mass transfer process, providing universal methodological support for the rational construction of high-performance electrocatalytic and energy-storage nanomaterials.

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Prof. Jian (Jeff) Liu, doctoral advisor, and dean of the School of Chemistry and Chemical Engineering at Inner Mongolia University. He has been selected as a Distinguished Professor under the Ministry of Education's Major Talent Program (2022) and as a recipient of the National Program for Introducing High-Level Overseas Talents (2017), among other honors. He has been named a Clarivate Highly Cited Researcher for six consecutive years (2018–2023). He has long been dedicated to the design and synthesis of nanoporous materials and their fundamental application research in energy and catalysis-related fields, achieving a series of significant original results in the design, synthesis, and application of catalytic nano-functional materials, as well as in the construction of nanoreactors. To date, as first author and (co-)corresponding author, he has published over 190 peer-reviewed papers in journals including *Nature Materials* (2 paper), *Nature Communications* (3 papers), *Angew. Chem. Int. Ed.* (14 papers), *Adv. Mater.* (5 papers), *Natl. Sci. Rev.* (2 papers), among others, as first author and (co-)corresponding author. His published papers have been cited over 24,000 times in SCI-indexed journals, with an H-index of 72. He has authored 10 chapters in English textbooks, published one monograph, and has been invited on multiple occasions to deliver invited presentations at academic conferences both domestically and internationally.

He has led or participated in numerous research projects, including key R&D projects funded by the Organization Department of the CPC Central Committee and the Ministry of Science and Technology; major instrument development projects funded by the National Natural Science Foundation of China; general projects funded by the National Natural Science Foundation of China; projects funded by the Chinese Academy of Sciences; projects funded by the Organization Department of the Liaoning Provincial Committee of the CPC; projects funded by the Organization Department, Department of Human Resources and Social Security, and Department of Science and Technology of the Inner Mongolia Autonomous Region; and general projects funded by the Australia Research Council. He has received the Young Scientist Award at the 14th International Congress on Catalysis (2008), the IAAM Medal (2021), the International VEBLEO Outstanding Scholar Award, the Second Prize in the Basic Research Award from the Chinese Chemical Society (2021, first author), and the First Prize in the Liaoning Provincial Natural Science Academic Achievement Award (2022), among other honors. He currently serves as Editor-in-Chief of *Materials Today Sustainability*, a journal published by Elsevier, and as a member of the editorial board for *National Science Review* and other journals.

Prof. Xiaoguang Duan
Adelaide University, Australia

Day 1: 16:10-16:30, Keynote Talk

Title: Catalytic Pollutant Upcycling via Nonradical Advanced Oxidation

Abstract: Advanced oxidation processes (AOPs) have garnered wide attention as a promising solution to the dual pressures of water pollution and carbon emissions. Unlike conventional radical-based Fenton systems that rely on intense oxidation and substantial oxidant consumption to degrade pollutants into CO_2, we discovered a new electron-transfer pathways (ETP) that offer enhanced selectivity toward micropollutants in complex water environments. The ETP regime was triggered via non-radical persulfate activation, yielding surface complexes that selectively oxidize and convert phenolic and aromatic contaminants into polymeric products under moderate conditions with stoichiometric peroxide consumption. Such a process enables selective pollutant removal alongside resource valorization into value-added products at very low chemical consumption. We investigated how metal oxides and carbon nanomaterials trigger distinct ETP pathways and revealed that catalyst structure and chemical properties are pivotal in regulating peroxide activation, thus steering the micropollutant removal toward polymer formation rather than decomposition. Through micro-field intensification and heterojunction engineering, sustained oxidation and polymerization can be driven in parallel, boosting system stability and polymer yields. This "waste-to-resource" approach renovates AOP technologies toward sustainable water treatment and resource recovery.

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Prof. Zhenguo Huang

University of Technology Sydney, Australia

Day 1: 16:25-16:45, KeynoteTalk

Title: Hydrogen-rich bond (N-H, O-H, and B-H) for Energy Storage and Transfer

Abstract: Hydrogen-rich systems composed of light elements such as B, C, and N have been extensively explored as hydrogen-storage materials. In this talk, I will first give a brief overview of borohydrides for hydrogen storage, such as room-temperature hydrogen cycling by LiBH4, improved synthesis of NaBH4 and Mg(BH4)2. I will then discuss reactions between amine–borane complexes and amines that generate high-purity H_2 under ambient conditions. For example, the reaction between ethylenediamine bisborane (EDAB) and ethylenediamine (ED) yields unique B–C–N five-membered rings in the dehydrogenation product, in which one boron is tri-coordinated by three nitrogen atoms. I will also introduce 1,6;2,3-bis-BN cyclohexane—an isostere of cyclohexane with two adjacent BN pairs—which has an attractive hydrogen-storage capacity of >9.0 wt%, nearly twice that of 1,2;4,5-bis-BN cyclohexane. Finally, I will share our latest progress on electrolysis of ammonia/water solutions to produce green hydrogen and nitrite/nitrate, as well as the electrochemical conversion of CO2 to formic acid.

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Professor Zhenguo Huang is Director of the Centre for Green Technology at the University of Technology Sydney (UTS), where he leads a cross-disciplinary team advancing renewable fuels. His research centres on boron chemistry for energy conversion and storage, spanning hydrogen-storage materials, electrolytes, and 2D boron-containing nanosheets. He has held an ARC DECRA and an ARC Future Fellowship, serves as a Research Advisor at Japan's National Institute for Materials Science, and is a Humboldt Research Fellow (Alexander von Humboldt Foundation). He chairs the International Hydrogen Carriers Alliance

Dr. Peng Li
RMIT University, Australia

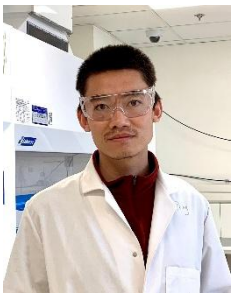
Day 1: 16:50-17:05 pm, Invited Talk

Title: Tandem Carbon Capture and Electrochemical Conversion for Chemicals Production

Abstract: The urgent need to mitigate industrial CO_2 emissions has driven global efforts to integrate carbon capture and utilization (CCU) technologies.[1,2] However, conventional amine scrubbing processes suffer from high energy penalties due to the thermal regeneration step, while gas-fed CO_2 electrolysis systems often face issues related to low CO_2 solubility, purity requirements, and scale-up challenges. In this work, we present a new tandem system that directly couples amine-based CO_2 capture using piperazine (PZ) with electrochemical conversion, bypassing the need for energy-intensive CO_2 desorption.[3-5] Instead of releasing gaseous CO_2, the captured carbamate species formed in PZ solution are directly electrolyzed into value-added products. To facilitate this transformation, we have designed and screened nickel single-atom catalysts (Ni SACs), which exhibit outstanding activity and selectivity for carbamate reduction under room temperature conditions. Our integrated approach achieves high Faradaic efficiencies and current densities, while significantly reducing overall energy input compared to conventional CCU routes. This work not only demonstrates a practical pathway for electrifying post-combustion capture processes but also opens a new paradigm for "capture-to-conversion" technologies that are scalable, retrofittable, and compatible with existing infrastructure. The insights into carbamate reactivity and catalyst design offer a platform for future development toward direct air capture, flue gas utilization, and net-zero industrial applications

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Peng Li received his PhD degree under the supervision of Prof. Shi Xue Dou from the University of Wollongong in 2020. Currently, he works as an ARC DECRA research fellow at RMIT University under the mentorship of Prof. Tianyi Ma. His research combines mechanistic electrochemistry, catalyst design, and device engineering to develop practical pathways for converting captured CO_2 into valuable chemicals and fuels, while also informing broader innovations in clean energy conversion and storage.

Dr. Liang Jason Wang
Griffith University, Australia

Day 1: 17:05-17:20 pm, Invited Talk

Title: Interface Engineering of Heterostructures for Energy Storage and Conversion

Abstract: Interface engineering in heterostructured nanomaterials has emerged as an effective strategy for optimizing charge transport, reaction pathways, and electrochemical stability in energy storage and conversion systems. However, the rational design and construction of functional interfaces remain challenging. In this presentation, we propose an interface-centred design framework spanning photocatalysis, electrocatalysis, and alkaline metal batteries. We highlight how atomic- and molecular-level heterointerfaces can be rationally engineered to tune electronic structures and regulate interfacial processes, thereby enhancing performance in photocatalysis, electrocatalysis, and energy storage applications.[1-7]

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Room #2: Solar 3

Prof. Itaru Osaka

Hiroshima University, Japan

Day 1: 15:45-16:05, Keynote Talk

Title: Conjugated Polymers Based on Benzothiadiazole-Containing π-Extended Fused Rings for High-Performance Organic Photovoltaics

Abstract: Benzothiadiazole and its derivatives have been widely utilized as key building blocks for organic electronic materials. We have previously developed a series of π-conjugated polymers based on naphthobisthiadiazole, in which two benzothiadiazole units are fused, and demonstrated their high charge-transport properties and excellent photovoltaic performance. In this study, we report π-conjugated polymers incorporating a newly designed benzothiadiazole-containing fused ring, named dithienonaphthobisthiadiazole (TNT), where two thiophene rings are fused to a naphthobisthiadiazole core. The TNT-based polymers exhibit several intriguing characteristics arising from their rigid and π-extended backbones. For instance, a TNT–bithiophene copolymer shows high charge-carrier mobility despite its relatively low crystallinity. Furthermore, this polymer achieves a high fill factor exceeding 80% in photovoltaic cells using fullerene as the acceptor, even with photoactive layers as thick as 300 nm. Another TNT-based polymer, incorporating benzodithiophene as a co-monomer unit, exhibits a remarkably high photocurrent in non-fullerene solar cells, despite a small HOMO energy offset, as evidenced by its small nonradiative voltage loss. The synthesis, optoelectronic properties, and structure–property relationships of these TNT-based polymers will be discussed.

Keywords: Conjugated polymers, Semiconducting polymers, Organic photovoltaics, Non-fullerene

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Itaru Osaka received his Ph.D from University of Tsukuba in 2002. After a 4-year research stint at Fujifilm, he joined Professor R. D. McCullough's group at Carnegie Mellon University as a postdoctoral fellow in 2006. He then started his professional career at Hiroshima University as an Assistant Professor in 2009, and moved to RIKEN as a Senior Research Scientist in 2013. He was appointed as a Professor at Hiroshima University in 2016. His research interests include the design and synthesis of π-conjugated materials and polymers for organic electronics.

Prof. Rongkun Zheng
The University of Sydney, Australia

Day 1: 16:05-16:25, Keynote Talk

Title: Optimising 2D FA Perovskites for Stable and Efficient Solar Cells

Abstract: Perovskite solar cells (PSCs) have made remarkable strides in achieving high power conversion efficiency, but their commercialization is still challenged by stability issues. Formamidinium (FA)-based two-dimensional (2D) perovskites have emerged as highly promising candidates due to the outstanding optoelectronic characteristics exhibited by inherent FA-based perovskites and enhanced environmental stability provided by 2D structures. The efficiency and stability of FA-based 2D PSCs are still relatively low.

In the first work using one-step deposition method. We tuned the Pb-I octahedral twisting and lattice distortion by organic spacer cation engineering to stabilize the FA-based 2D perovskite lattice. We further modulated the crystallization kinetics with a molecular-type Selenourea (SU) additive to inhibit the in-plane growth of quantum wells in 2D perovskites. The optimized FA-based 2D PSCs achieved a record-high power conversion efficiency (PCE) of 20.03% and exhibited less than 1% efficiency degradation after operating at maximum power point for 1000 hours.[1]

In the second work, we developed an additive-stabilized spacer-cation-preponed two-step deposition method to achieve the out-of-plane orientation and grain sizes larger than 5 μm in 2D perovskites. The optimized 2D PSCs achieved a high PCE of 21.16% and a short-circuit current of 23.71 mA cm^{-2}, among the highest in 2D PSCs. The PSCs demonstrate remarkable stability, with a PCE decrease of less than 5% after exposure to 65±10% humidity for 1100 hours, operation at 85°C for 1077 hours, or continuous illumination for 1045 hours.[2]

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Rongkun Zheng obtained his BSc in Physics from Shandong University in China in 1999 and his PhD in Physics from the Hong Kong University of Science and Technology in 2004. He joined the University of Sydney in late 2004 and currently is a Professor at the School of Physics. His research interest spans from Condensed Matter and Materials Physics to Microscopy and Microanalysis, with a focus on the growth-structure-property relationships in functional materials and devices using sophisticated microscopy and microanalysis. He has published more than 300 papers with more than 15000 citations. He has received a number of awards, including a prestigious fellowship from the Australian Research Council, and has been regularly invited to international conferences in his field.

Dr. Peng Chen
University of Queensland, Australia

Day 1: 16:25-16:45, Invited Talk

Title: 2D/3D heterostructures for efficient tin-based perovskite solar cells

Abstract: Tin halide perovskites (THPs) have emerged as promising lead-free candidates for eco-friendly perovskite solar cells, but their photovoltaic performance still lags behind that of lead-based counterparts due to poor thin-film quality. Constructing two-dimensional/three-dimensional (2D/3D) heterostructures can effectively regulate crystallization and suppress defect formation for developing high-quality THP thin films.[1,2] Here, we introduced colloidal chemistry engineering strategies to synchronize the nucleation kinetics of 2D and 3D phases for the growth of homogeneous 2D/3D THP heterostructures.[3] Consequently, the optimized devices deliver an excellent power conversion efficiency of 17.13% (certified 16.65%) and exhibit stable operation under continuous one-sun illumination for over 1,500 h in nitrogen without encapsulation. This study offers new insights into colloidal chemistry and crystallization engineering of mixed-dimensional heterostructures, paving the way for high-performance lead-free perovskite photovoltaics.

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Dr. Kaiwen Sun
University of New South Wales, Australia

Day 1: 16:45-17:00, Invited Talk

Title: Wide-Bandgap Cu-Based Chalcogenide Solar Cells for Next-Generation Tandem Photovoltaics

Abstract: Silicon photovoltaics has achieved remarkable commercial success and is now approaching its practical efficiency limit, motivating the development of tandem solar cells that can more effectively utilise the solar spectrum. Wide-bandgap thin-film solar cells are critical to this transition, serving as the top-cell component in Si-based tandem architectures. Among the emerging candidates, Cu-based chalcogenide materials, particularly chalcopyrite $Cu(In,Ga)(S,Se)_2$ and kesterite Cu_2ZnSnS_4, offer a compelling combination of strong optical absorption, bandgap tunability, excellent material stability, and potential compatibility with scalable low-cost manufacturing. Recent progress at the University of New South Wales in developing wide-bandgap CIGS and CZTS solar cells for tandem photovoltaic applications will be discussed. For wide-bandgap CIGS, solution-processing approaches enable precise composition control, improved material utilisation, large-area uniformity, and compatibility with continuous manufacturing. Key advances include vertical Ga grading, alkali-metal doping, defect suppression, phase-transition control, and recent efficiency breakthroughs. For high-bandgap CZTS, more than a decade of development in sulfide kesterite solar cells will be reviewed, focusing on absorber bulk engineering, front and rear interface optimisation, Cd-free buffer layers, passivation strategies, alloying/doping approaches, and hydrogen treatment.



Dr Kaiwen Sun is an ARC DECRA Fellow & Senior Lecturer at the School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, (UNSW). He completed his PhD in investigating CZTS thin film solar cells at UNSW in 2018. After completion of his PhD, he was awarded Australian Centre for Advanced Photovoltaics (ACAP) research fellowship in 2017 and ARC DECRA Fellow in 2022. His research focuses on developing high-efficiency earth-abundant and non-toxic Cu based chalcogenide thin film solar cells, which enables broadening the application of PV technologies into niche market and exploring high bandgap top cell alternative for Si-based tandem cell.

Dr. Ning Song
University of New South Wales, Australia

Day 1: 16:45-17:00, Invited Talk

Title: Materials and Device Innovation for High-Performance and Next-Generation Photovoltaics

Abstract: Silicon photovoltaics continue to play a central role in the global transition towards sustainable energy, while rapid advances in materials and device engineering are creating new opportunities for higher efficiency, improved reliability, and reduced manufacturing cost.
This presentation will highlight our recent research on advanced silicon photovoltaics, with a focus on passivating-contact technologies, interface and contact engineering, metallisation, and device reliability. Particular attention will be given to understanding the relationships between material properties, interfaces, processing conditions, and device performance, and to translating these insights into technologically and industrially relevant photovoltaic solutions. Recent research on photovoltaic reliability under conventional and extreme operating environments will also be discussed.
Looking beyond current silicon technologies, the presentation will explore emerging opportunities for next-generation photovoltaic materials and devices. In particular, machine learning, computational modelling, and data-driven approaches offer new possibilities to navigate complex materials and processing spaces, identify promising material–device relationships, and accelerate research and development. Integrating these approaches with materials science, device physics, and experimental validation may provide a powerful pathway towards more efficient discovery and engineering of future photovoltaic technologies.

Keywords: Silicon photovoltaics; Interface engineering; Reliability; Machine learning; Next-generation energy materials.



Dr Ning Song is a Senior Lecturer in the School of Photovoltaic and Renewable Energy Engineering at UNSW Sydney. Her research focuses on advanced silicon photovoltaics, including passivating-contact technologies, interface and contact engineering, metallisation, and photovoltaic reliability. Her work bridges fundamental materials and device physics with industry-relevant innovation for high-efficiency and low-cost solar technologies. Her current research interests are also expanding towards machine learning and computational approaches for next-generation photovoltaic materials and devices. Dr Song works closely with academic and industrial partners to translate materials innovation into practical photovoltaic technologies.

Ji Cao

University of Queensland, Australia

Day 1: 17:00-17:15, Oral Talk

Title: Surface Interface Engineering for Wide-Bandgap *p-i-n* Perovskite Solar Cells

Abstract: Perovskite/Si tandem solar cells, featuring high spectral utilization and outstanding efficiency potential, have demonstrated significant performance advantages over single-junction solar cells.[1, 2] Wide-bandgap (WBG) perovskites are widely employed as the absorber in the top cell, where they absorb high-energy photons and transmit lower-energy photons to the Si bottom cell.[3, 4]However, significant challenges remain for optimizing the performance of WBG PSCs.[5] Compared with narrow-bandgap perovskites, WBG perovskites exhibit faster crystallization kinetics, leading to reduced crystallinity, increased surface trap density, and enhanced non-radiative recombination.[6] Their higher bromide content also makes them more susceptible to phase segregation, particularly near the surface, resulting in decreased bandgap and reduced stability.[7] In addition, energy-level misalignment at the perovskite/C_{60} interface hinders charge extraction and transport.[8] Therefore, effective interface engineering is crucial for WBG PSCs. Here, we employed a rational molecular design strategy to develop a series of interfacial modifiers designed to suppress the formation of thick 2D phases while maintaining effective surface passivation. Pentafluorophenethyl derivatives were synthesized, with the choice of halide anions systematically varied to tune interfacial interactions, dipole formation, and energy-level alignment. In addition, diethylammonium-substituted derivatives were introduced to further modulate molecular packing and interfacial properties, providing insight into the influence of cation configuration on passivation and charge transport. In this work, nine passivation materials, including a series of cyclohexyl-based organic halide derivatives, and benchmark materials were investigated. Systematic variation of the cationic backbone and terminal halides enabled the influence of molecular structure on passivation. The best-performing FEA-Cl treatment was found to increase the PCE from 20.5% to 22.1% for inverted devices featuring a 1.68 eV WBG perovskite. Given the theoretical efficiency limit of ~29% for a 1.68 eV perovskite, the significant efficiency improvement achieved using FEA-Cl demonstrates the strong potential of this interfacial engineering strategy.

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Room 3: Battery 2

Prof. Mainak Majumder

Monash University, Australia

Day 1: 15:50-16:10, Keynote Talk

Title: Holistic design of faster, thinner and longer-lasting Lithium Sulfur batteries

Abstract: The mature and reliable Lithium-ion battery (LiB) technology (<265 Wh kg^{-1}) is unlikely to be entirely replaced and yet is set to see a few competing battery chemistries that can outperform in more than one index of performance. Lithium-Sulfur (Li-S) battery is one such chemistry that promises a safer, more energy-dense, less expensive, and more sustainable storage technology. I will describe the principal components of a LiS battery, the role and function of each component and the ideal characteristics that are required to overcome the principal challenges for designing practical batteries including issues such as increasing the areal Sulfur loading (> 4-5 mg_s/cm^2), decreasing the electrolyte requirements E/S ratio, increasing the coulombic efficiency and the cycle life, and finally, the design and manufacturing of LiS pouch cells. To address these challenges, we have developed novel microstructures within the cathode capable of handling stress associated with lithiation and de-lithiation steps termed 'expansion tolerant architectures' [1]; introduced polysulfide regulating functional properties into cathodes by including molecules with redox properties [2]; and sulfur cathodes containing self-organized cellulose nanofibers [3] with low electrolyte to capacity ratio (<5 µL mAh^{-1}) and high ion and electron conductivity. These innovations have resulted in our team being able to produce >300Wh/Kg LiS Ah-level pouch cells which have shown to extend the cruising range of drones. One key component of the Li–S battery is the separator, because it holds tremendous promise for improving cycle-life by mitigating the well-known polysulfide shuttle, enabling lean electrolyte configurations, and restricting solid electrolyte interphase growth at the Li-metal anode [4]. We have demonstrated various new concepts such as self-assembled polyelectrolyte nanoparticles deposited on Celgard as functional separators [5]. Role of additives such as porous aromatic framework (PAF) decorated with sulfonated groups show polysulfide retention properties in conjunction with high Li^+ -ion diffusion properties [6]. We have mimicked cell plasma membranes by integrating the abilities to provide rapid and permselective Li^+ channels alongside catalytic electrochemical reactions, we demonstrate a paradigm shift in the role of interlayers for achieving high-performance and practical Li-S batteries [7]. Our recent contributions have aimed at accelerating the polysulfide redox reactions by harnessing the bi-directional catalytic properties of polymer-metal and polymer-halogen complexes. These studies have shown the potential of enhancing the power delivery (or C-rate) of Lithium Sulfur batteries, which has been considered to be a major bottleneck for market adoption [8].

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Biography: Mainak Majumder is a professor in the Department of Mechanical and Aerospace Engineering of Monash University, where he has been since 2010. He joined Monash after a two-year postdoctoral stint at Rice University, USA with Professors P.M. Ajayan and Matteo Pasquali. He earned a PhD with Professor Bruce J. Hinds at the University of Kentucky, USA studying mass and molecule transport in aligned carbon nanotube membranes. Currently, he is the Director of the Australian Research Council's Research Hub on Advanced Manufacturing with 2D Materials (https://am2d.org), which is a $9M initiative of the Australian government with local industries to support commercialization of Graphene-enabled technologies. He is also the Senior Advisor of the Monash Energy Institute (https://www.monash.edu/energy-institute), a local organization dedicated to maximising the impact of energy research at Monash University. He is the co-founder of Ghove Energy, a Monash spin-out, which is commercializing Lithium Sulfur battery technology for the advanced air mobility market.

Prof. Caiyun Wang
University of Wollongong, Australia

Day 1: 16:10-16:30, Keynote Talk

Title: Biobatteries: Advancing Energy Storage for Bioelectronic Applications

Abstract: Biobatteries are an emerging type of energy storage system designed to be implanted in or attached to the human body. In these systems, body fluids can function as electrolytes, while the cytocompatible electrodes are engineered to enable controlled degradation when needed. Conductive hydrogels are ideal electrode materials because they combine soft, tissue-like mechanical properties with good electrical conductivity and energy storage performance.[1,2] They also integrate well with biological tissues, supporting both electrical stimulation and cell interactions. Beyond serving as power sources for medical devices, biobatteries can promote therapeutic effects by generating localized electrical signals and releasing beneficial biochemical products.[3] These multifunctional properties have attracted increasing interest for cell-based studies and disease management, particularly in applications where bioelectrical cues play a critical role, such as drug delivery[4], wound healing[5], immunotherapy[6], and cardiac arrhythmia management[7].

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Dr. Wang is currently a Professor/Professorial Fellow at the Intelligent Polymer Research Institute/Faculty of Engineering and Information Sciences, University of Wollongong. Her research interests include synthesis and application of conducting polymers and 2D materials for wearable/implantable energy storage devices, nanostructured catalysts for electrochemical reduction of CO2, and asymmetric membranes for osmotic power generation. Her work focuses on understanding the structure-property relationship of these materials and elucidating the mechanisms.

Prof. Meinan Liu
Guangxi University, China

Day 1: 16:30-16:50, Keynote Talk

Title: Delicate Design of Solvation Chemistry for High-Performance Lithium Metal Batteries

Abstract: With the fast development of electronic devices, the requirements on batteries with high-energy and all-temperature are urgently needed. Rechargeable lithium-metal batteries (LMBs), are considered as compelling substitutes for conventional lithium-ion batteries in near future due to their high energy-density contributed by the high theoretical capacity (3,860 mAh g^{-1}) of Li metal anode (LMA). However, Li anode with a low standard electrode potential of -3.04 V (versus the standard hydrogen electrode) is so energetic that it can easily react with traditional carbonate electrolytes, resulting in uncontrolled side reactions and dendrite growth. To address these issues, a stable and efficient electrode/electrolyte interphase (EEI) is keen to established in LMBs. The solvated Li^+ structure has significant influence in EEI components. How to rationally design electrolyte chemistry to affect the solvation structure, and finally influence the EEI is quite important [1-3]. In our work, a series of strategies have been developed to achieve this delicate design on solvation chemistry, and thus obtain advanced EEI, and simultaneously reduced desolvation energy on interphase [4,5]. The enhanced Li^+ diffusion kinetics through tuning solvation structure not only prolongs the life-span of LMB, but also empowers LMB working functionally in a wide temperature range (-20–60 °C); which will boost the practical application of high-performance LMB in real world.

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Biography: Dr Meinan Liu is a Professor at Guangxi University. Her research is focus on development of high performance of energy storage devices. She has carried out extensive research in solvation chemistry to address the sluggish diffusion kinetics in lithium batteries, especially at low temperature. She has published over 100 peer-reviewed scientific articles. She was also an inventor of 20 patents in the area of energy materials and applications.

Dr. Fan Zhang
Queensland University of Technology, Australia

Day 1: 16:50-17:05, Invited Talk

Title: Electrolyte engineering for long life-span aqueous Zinc ion battery

Abstract: Aqueous zinc-ion batteries (AZIBs) are attractive energy-storage systems owing to their high safety, low cost, and environmental sustainability. However, their practical deployment is hindered by sluggish Zn^{2+} transport, non-uniform zinc deposition, and parasitic side reactions, all of which compromise cycling stability and reversibility.[1] Therefore, precise regulation of Zn^{2+} transport behavior is critical for achieving high-performance zinc-based batteries. In this work, we present a molecular-level electrolyte engineering strategy to regulate Zn^{2+} transport through simultaneous modulation of the solvation structure and hydrogen-bonding network. The introduced functional additive interacts strongly with both Zn^{2+} ions and surrounding water molecule, reconstructing the local coordination environment and facilitating Zn^{2+} migration. As a result, the electrolyte exhibits accelerated ion transport kinetics, reduced transport resistance, and a lower activation energy for Zn^{2+} transfer.[2-4] Comprehensive spectroscopic and electrochemical analyses reveal that the optimized electrolyte promotes a more homogeneous Zn^{2+} flux at the electrode/electrolyte interface, enabling uniform zinc nucleation and deposition. The regulated Zn^{2+} transport behavior effectively suppresses dendrite formation and mitigates interfacial side reactions, leading to enhanced zinc plating/stripping reversibility. This study highlights the pivotal role of Zn^{2+} transport regulation in governing zinc electrochemistry and provides fundamental insights into the relationship between solvation chemistry, interfacial ion transport, and electrochemical performance. The findings offer an effective strategy for developing durable and high-performance aqueous zinc-based energy-storage systems.

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Biography: Fan Zhang is now a Research Associate at Queensland University of Technology. His research mainly focuses on aqueous batteries, high performance electrolyte and bioinspired materials design. He has published 10 high-impact journals as first/corresponding authors in Nat. Commun., J. Am. Chem. Soc., Adv. Mater. Nat. Sci. Rev.et al.

Shangxu Jiang
Flinders University, Australia

Day 1: 17:05-17:17, Oral Talk

Title: Caging Polyhalide Anions in Polycyclodextrin for Long-Lasting Aqueous Zinc–Iodine Batteries

Abstract: Aqueous zinc batteries have attracted increasing attention as promising alternatives to lithium-ion batteries for safe, low-cost, and sustainable energy storage. Among various cathode chemistries, iodine is particularly attractive because of its high theoretical capacity, fast redox kinetics, and compatibility with aqueous electrolytes. However, the practical development of aqueous zinc–iodine batteries is strongly limited by the dissolution and crossover of polyiodide species, which lead to active material loss, zinc corrosion, low Coulombic efficiency, and rapid capacity fading. This challenge becomes more complicated in advanced four-electron iodine chemistry, where mixed polyhalide species must also be stabilized during the $I^-/I_2/I^+$ conversion. In this work, we develop a host–guest chemistry strategy to cage polyhalide anions within crosslinked polycyclodextrin cathodes. Cyclodextrins possess hydrophobic molecular cavities that can specifically accommodate polyiodide and mixed polyhalide species, while the crosslinked polymer network prevents dissolution of the host material. By comparing different cyclodextrin cavities, we show that poly(β-cyclodextrin) provides a suitable balance between polyhalide confinement and reversible transport, enabling efficient redox conversion without severe shuttle effects. The optimized poly(β-cyclodextrin)/KI_3 cathode supports both two-electron I^-/I_2 storage and four-electron $I^-/I_2/I^+$ storage in aqueous zinc batteries. The batteries deliver high capacities, stable voltage plateaus, excellent rate capability, and ultralong cycling stability over 60,000 cycles. Pouch-cell tests further demonstrate the practical potential of this molecular-caging strategy. This work provides a sustainable and cost-effective host–guest design principle for suppressing polyhalide shuttling, highlighting the importance of balancing polyhalide binding strength and redox kinetics for developing long-lasting aqueous zinc–iodine batteries.

Keywords: aqueous zinc-iodine batteries; shuttle effect; four-electron iodine chemistry; polycyclodextrin; polyhalide

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Zia Ud Din
Queensland University of Technology, Australia

Day 1: 17:17-17:29, Oral Talk

Title: Polyethylene glycol Modified porous Sulfonated Poly (ether ether ketone) separator for highly Stable Aqueous Zinc-Ion Batteries

Abstract: Aqueous zinc-ion batteries (AZIBs) are attractive candidates for safe and sustainable energy storage; however, their commercialization is hindered by zinc dendrite growth, hydrogen evolution, corrosion, and non-uniform Zn^{2+} transport [1]. Separator engineering has emerged as an effective strategy to regulate ion transport and stabilize zinc plating/stripping. Herein, we fabricated a porous and excellent ion-selective polyethylene glycol (PEG)-modified sulfonated poly (ether ether ketone) (SPEEK) separator for high-performance AZIBs [2]. The separator was fabricated via a phase inversion process to produce an interconnected porous architecture, using PEG as sacrificial agent to improve hydrophilicity and electrolyte affinity. The degree of sulfonation was optimized to approximately 65–70%, providing sufficient ionic conductivity while maintaining excellent mechanical integrity and dimensional stability [3]. The resulting separator possessed a thickness of approximately 40 μm, enabling rapid ion transport while maintaining effective physical separation between the electrodes. Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) analyses confirm a well-developed porous morphology, while cross-sectional SEM further verifies interconnected ion transport channels and uniform structural integrity. The synergistic combination of sulfonic acid functional groups, interconnected porous channels, and PEG facilitates preferential Zn^{2+} transport, suppresses anion migration, homogenizes ionic flux, and mitigates dendrite formation and parasitic side reactions. Electrochemical evaluation demonstrates outstanding zinc plating/stripping reversibility and interfacial stability so far. Zn||Zn symmetric cells exhibit stable cycling for over 2000 h at 0.5 mA cm^{-2}/0.5 mAh cm^{-2} and maintain stable operation for more than 1100 h at 1 mA cm^{-2}/1 mAh cm^{-2} with low polarization. Furthermore, Zn||Cu half cells achieve an average Coulombic efficiency of 99.8% for more than 3000 cycles at 1 mA cm^{-2}/0.25 mAh cm^{-2}, confirming highly reversible zinc deposition and stripping. These findings demonstrate that the porous SPEEK-PEG membrane effectively regulates Zn^{2+} transport while suppressing dendrite growth and interfacial side reactions. This scalable polymer-based separator provides a promising strategy for developing durable, high-efficiency aqueous zinc-ion batteries for next-generation energy storage applications.

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Room 4: Carbon Materials

Prof. Hongwei Wu

Curtin University, Australia

Day 1: 15:50–16:10, Keynote Talk

Title: Biocarbon for low-emissions metals and energy applications

Abstract: Biomass is expected to play an important role in future low-emission energy and metals applications and in advancing a circular economy. This talk begins by outlining the key biomass characteristics that must be considered in these applications. Biomass is widely dispersed, locally available, bulky, moisture-rich, and low in energy density, which creates high logistics costs in practical use. Its fibrous structure and poor grindability also mean that plants using biomass directly as feedstock should be distributed, small-scale, and flexible enough to handle large particles. During thermochemical processing, biomass conversion is dominated by gas-phase reactions because of its high moisture and volatile contents, which can create mismatches in fuel properties when biomass is co-processed in existing stationary plants. The talk then identifies pyrolysis as a flexible thermochemical technology for local processing. Pyrolysis can convert biomass into bioproducts with high volumetric energy density, making them more suitable for transport. The yields and properties of these products depend strongly on feedstock characteristics, processing conditions, and underlying reaction mechanisms. This supports a supply-chain concept in which multiple distributed, small-scale pyrolysers produce high-volumetric-energy-density products near biomass sources, while centralised facilities use products transported from these sites. Australia has abundant biomass resources that could significantly help decarbonise hard-to-abate sectors, including low-emission energy and metals. The talk also discusses opportunities to establish such supply chains for selected biomass-derived bioproducts in Australia. It concludes by outlining the essential R&D needed to address related challenges, including deeper understanding of reaction mechanisms, tailored process conditions and configurations for targeted applications, and scale-up and demonstration.



Short Bio: Prof Hongwei Wu received his PhD in Chemical Engineering from the University of Newcastle, Australia. He is a Professor of Chemical Engineering at Curtin University, where he leads the High Temperature Processing Laboratory and a sizeable research team. His research focuses mainly on thermochemical processing of solid fuels, biofuels and biochemicals, biocarbon, and low-emission metals. He received the 2010 Curtin Commercial Innovation Award and the 2011 Western Australia Innovator of the Year Woodside Encouragement Award, as well as the inaugural 2018 Curtin Award for Excellence in Higher Degree by Research Supervision. His research has led to new technologies and spin-off activities. Prof Wu was elected a Fellow of the Combustion Institute in 2019. Since January 2020, he has served as Editor-in-Chief of *Energy & Fuels*, a journal published by the American Chemical Society.

Assoc. Prof. Hong Li
Nanyang Technological University, Singapore

Day 1: 16:10-16:30, Keynote Talk

Title: Carbon-Negative Hydrogen

Abstract: Climate change caused by carbon emission is a global challenge that necessitates urgent action and leads to the sustainability shift towards low-carbon biofuels, renewable energy, and clean hydrogen fuel, as well as green chemicals. Hydrogen is playing an increasingly critical role in peak shaving for renewable energy, acting as a flexible, long-duration energy storage solution to manage the intermittency of wind and solar power. High-purity hydrogen can be generated from water electrolysis but is hindered by kinetically sluggish oxygen evolution reaction (OER) and the safety issue caused by possible explosive mixture of oxygen and hydrogen under the condition of partial loading and membrane degradation. This is also a key root cause for the uncompetitive cost of green hydrogen. There is thus a widespread effort to replace OER with the more favorable electrooxidation of small organic molecules. Although value-added products can be generated, the production of these organics is process-intensive and costly. They lack the abundance necessary to meet the requirements of a hydrogen economy. Abundant raw biomass with annual production of billions of tons in nature are promising alternatives to these small organics. Significantly, biomass reforming via electrooxidation (to replace OER) could close the carbon cycle and promote a circular economy. Therefore, from both resources recovery and carbon abatement perspectives, it is critical to develop advanced electro-refinery system for biomass valorisation. Biomass waste was featured as a promising reactant for reforming due to their abundance and availability. Without proper handling, these waste release carbon back into the atmosphere only after a short period of storage, rendering advanced carbon storage and utilization crucial. Reforming biomass waste not only produces green commodity chemicals and hydrogen fuels but also holds promising potential for climate change mitigation. Herein, I summarize our recent works [1-9] on reforming various wastes into green hydrogen and chemicals.

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Dr. Hong Li is currently a Professor in Nanyang Technological University (NTU) in Singapore. Before he joined NTU in June 2016, he was a postdoc in Stanford University in United States. Dr. Li focus on renewable energy and sustainability including green hydrogen generation, biomass reforming, and passive cooling. Dr. Li has published more than 120 peer-reviewed papers in international journals including Science, Nature Materials, Nature Communications, Nano Letters, Journal of American Chemical Society *etc*. His publications have received more than 23,000 citations.

Dr Sam (Xianjue) Chen
The University of Newcastle, Australia

Day 1: 16:30-16:45, Invited Talk
Title: Fullerene Architecture

Abstract: Fullerenes, *e.g.*, C_{60}, are ideal structural and templating clusters due to their identical molecular structure, well-established chemistry, and availability in high purity and large quantities.[1–3] In this talk, I will present our recent efforts on solid-state transfer of C_{60} molecular nanometer-thin films onto various substrates, with dimensions of centimeters in lateral size and thicknesses controlled between 1–20 nm. I will also discuss the fabrication of centimeter-wide graphene/C_{60} heterostructures through stacking of C_{60} and CVD-grown graphene films. This approach also allows complete transfer of chemically modified C_{60} films, including oxygenated C_{60} films and $C_{60}Pd_n$ organometallic complex films, the latter of which can be directly transferred onto glassy carbon electrodes for probing hydrogen evolution reactions.[4] If time permits, I will introduce an alternative transfer strategy for fabricating large-area, *freestanding* C_{60} films. These transfer approaches could offer opportunities for the synthesis of novel carbon structures and probing their materials properties.

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Sam Chen is a Senior Lecturer and leads the Artificial Materials Lab at the University of Newcastle. He was awarded a PhD in Chemistry in 2014 from the University of Western Australia (UWA), followed by postdoctoral experiences at Flinders University, Ulsan National Institute of Science and Technology (UNIST), and University of New South Wales (UNSW). His group focuses on various aspects of advanced materials, particularly carbon materials, from developing new synthesis strategies, understanding of structures and properties, to the applications of new materials.

Xin Yang
Tohoku University, Japan

Day 1: 16:45-16:57, Oral Talk

Title: Orders-of-magnitude reactivity enhancement in persulfate activation by curvature-dependent oxygenated carbon nanotubes

Abstract: Advanced oxidation processes based on peroxymonosulfate (PMS) have attracted increasing attention for the refractory organic contaminant removal.[1,2] Yet, the structure-activity relationship governing PMS activation over carbon-based catalysts remains poorly understood.[3–5] Here, we demonstrate an orders-of-magnitude enhancement in PMS activation driven by curvature-dependent reactivity of carbonyl (C=O) active sites on carbon nanotubes (CNTs). Six CNT catalysts with diameters ranging from 1 to 60 nm and comparable surface oxygen functionalization were systematically investigated to decoupled curvature effects. Using 2,4-dichlorophenol as a target contaminant, 1 nm single-walled CNTs achieved pseudo-first-order reaction rate constants up to 0.67 min^{-1}, which were 1–2 orders of magnitude higher than those of large-diameter multi-walled CNTs. Turnover-frequency analysis, normalized to the abundance and surface density of C=O groups, revealed that this enhancement originated from the substantially higher intrinsic reactivity of individual C=O sites rather than from differences in active-site density or edge localization. Mechanistic investigations showed that highly curved CNTs preferentially activate PMS through non-radical pathways dominated by singlet oxygen ($^1O_2$) generation and electron-transfer processes, accounting for 90.1–94.6% of contaminant removal. Density functional theory calculations further demonstrated that increased curvature strengthens interfacial charge transfer and PMS adsorption, stabilizes key reaction intermediates, and lowers the energy barriers for $^1O_2$ formation. Furthermore, integration of CNTs into a membrane filtration device enabled contaminant removal efficiencies exceeding 90% during continuous operation for over 45 h in real water matrices. This work identifies CNT curvature as a key design parameter for engineering high-performance metal-free catalysts and provides new insights into the development of efficient PMS-based oxidation technologies.

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Yangyang Wang
The University of Sydney, Australia

Day 1: 16:57-17:09, Oral Talk

Title: Dynamic coupling of carbon deposition, electrical resistance and heat transfer in Joule-heated methane pyrolysis

Abstract: Electrified methane pyrolysis can co-produce hydrogen and solid carbon without direct CO_2 formation, but carbon accumulation on a resistive heating element can progressively change the reactor itself. This study investigates this dynamic coupling in a quartz-tube reactor containing a directly Joule-heated graphite rod. Experiments were conducted at 180–320 W, corresponding to initial maximum rod temperatures of 1500–1900 °C, with 20% CH_4 in Ar for up to 192 min. Methane conversion, product distribution, electrical behaviour, carbon growth and computational fluid dynamics (CFD) temperature fields were evaluated together. Initial methane conversion reached approximately 62%. During extended operation, pyrolytic carbon accumulated on the graphite rod and increased its maximum diameter from 2.0 to 4.7 mm under high-power conditions. The accompanying decrease in rod resistance altered current and power distribution across the electrical circuit, reducing the effective power delivered to the active heating zone. Consequently, the maximum temperature and methane conversion progressively declined, despite the enlarged heater surface area. CFD simulations showed that deposition-induced geometric changes redistributed the temperature field: the highest-temperature region contracted, while a larger lower-temperature volume developed around the thickened rod. Carbon characterisation further revealed power-dependent structural differences and island-like growth on the graphite surface. These findings establish a feedback loop between carbon deposition, heater geometry, electrical resistance, power distribution, temperature and reaction performance. Rather than treating carbon solely as a coproduct, stable Joule-heated methane pyrolysis must account for its continuous influence on reactor operation. The results provide practical guidance for heater design, circuit control and scale-up of electrified reactors for sustained hydrogen and carbon co-production.

Keywords: Methane pyrolysis; Joule heating; carbon deposition; electrified reactors; hydrogen production

Room 5: Theoretical and Machine Learning 1

Prof. Tao (Tom) Wu

The Hong Kong Polytechnic University, Hong Kong

Day 1: 15:50-16:10, Keynote Talk

Title: Navigate the Chemical Space of Organic Cations to Inverse Design Next-Generation Energy Materials

Abstract: The search for next-generation photovoltaics demands a radical shift from traditional trial-and-error discovery toward the targeted exploration of chemical space. As an emerging class of light-responsive semiconductors, hybrid organo-metal perovskites seamlessly marry the characteristics of organic and inorganic materials, offering a new fertile playground to explore light-matter interaction. Engineering organic cations has been pivotal in driving breakthroughs in the efficiency and stability of perovskite solar cells. However, the virtually infinite chemical space of organic molecules makes it impossible to navigate using the traditional approaches. To overcome this bottleneck, here, I will highlight our latest efforts to leverage inverse design frameworks powered by machine learning and generative artificial intelligence to navigate the vast chemical space of organic cations in hybrid perovskites. researchers are leveraging. Instead of screening existing compounds, we start with a set of desired target properties—such as the targeted energy band structure of two-dimensional hybrid perovskites. We then work backward to map directly to the molecular descriptors and novel molecular architectures. By integrating high-throughput screening with physical insights, we can rapidly predict, evaluate, and prioritize high-performing organic cations. Ultimately, the intricate interactions between organic molecules and the inorganic framework of hybrid perovskites enable effective passivation of perovskite surfaces, leading to high photovoltaic performance.

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Dr. Tom Wu is Chair Professor of Frontier Materials at the Hong Kong Polytechnic University. He received his B.S. degree from Zhejiang University and his Ph.D. from the University of Maryland, College Park. Before joining PolyU as a STEM scholar, Dr. Wu worked at Argonne National Laboratory, Nanyang Technological University in Singapore, King Abdullah University of Science and Technology in Saudi Arabia, and UNSW, Sydney. Dr. Wu has authored nearly 400 peer-reviewed papers with citations of over 45,000 and an H-index of 110 (Google Scholar), and he has been among the Clarivate List of Highly Cited Researchers since 2019.

Prof. Yan Jiao
Adelaide University, Australia

Day 1: 16:10-16:30, Keynote Talk

Title: Molecular Modelling for Electrocatalytic Clean Energy Conversion

Abstract: The goal of achieving zero-carbon emissions by 2050 has driven the search for alternative industry solutions that can replace the traditional fossil fuel-based economy.[1] With the technology and infrastructure in place to produce clean electricity from renewable sources such as solar or wind, the ability to generate it on a large scale is rapidly increasing. This presents a prime opportunity for the production of carbon-free fuels and chemicals through the use of electrocatalysis. Electrocatalysis enables the conversion of green electricity into chemicals and fuels, and vice versa, providing a path towards a sustainable future.[2]A grant challenge in electrocatalysis remains the design of highly active, selective, and stable catalyst materials and reaction environment.[3] Traditionally, molecular modelling has helped address this by offering insights into reaction mechanisms and guiding material and electrolyte design. Increasingly, artificial intelligence is playing a transformative role in this space. AI models trained on quantum mechanical data or experimental results can rapidly screen material candidates, identify structure-performance relationships, and uncover hidden patterns that may not be obvious through conventional approaches. My talk will highlight how we have used molecular modelling in the past for clean energy conversion reactions based on electrocatalysis, the emerging shift toward machine learning, and how it is expected to drive the next wave of breakthroughs in predicting and optimising electrocatalysts for clean energy applications.

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Professor Yan Jiao is Dean of the School of Chemical Engineering at Adelaide University and a leading researcher in computational electrochemistry and sustainable energy materials. She obtained her PhD in Chemical Engineering from The University of Queensland in 2012. Her research focuses on designing catalyst materials and reaction environments for sustainable energy conversion through molecular modelling and computational chemistry. She has published more than 160 journal articles in leading journals, attracting over 49,000 citations, with an h-index of 84. Since 2019, she has been named a Clarivate Highly Cited Researcher in Chemistry every year.

Dr. Carla Verdi
The University of Queensland, Australia

Day 1: 16:30-16:45, Invited Talk

Title: First-principles and machine learning 76odelling of polaron states and dynamics

Abstract: Polarons are quasiparticles formed by the coupling between electrons and lattice vibrations, leading to charge 76odelling76zi accompanied by structural distortions. They can strongly influence the fundamental properties and functionalities of materials, including charge transport, optical response, and chemical reactivity, yet remain challenging to model. In this talk, I will present recent advances in first-principles and machine learning modeling of polarons in real materials. In the first part, I will briefly introduce a first-principles theory of polarons that enables systematic calculations of polaron energies and their 76odelling electronic states, and apply it to investigate both large and small polarons in perovskite oxides. In the second part, I will present machine learning approaches that allow accurate and efficient modeling of complex polaronic systems. These include an automated workflow for identifying and 76odelling76zing polaronic states in defective environments, demonstrated for Nb-doped TiO_2 surfaces, and a machine-learning molecular-dynamics framework for simulating thermally activated polaron hopping. Applied to rutile TiO_2 surfaces, this approach reveals how charge-carrier diffusion is highly sensitive to the local surface environment. Overall, these developments enable systematic, large-scale investigations of polaronic effects, opening new avenues for understanding and engineering functional properties in complex materials.



Biography: Carla Verdi is a Lecturer in the School of Mathematics and Physics at the University of Queensland and an Associate Investigator at the ARC Centre of Excellence in Quantum Biotechnology. She received her PhD at the University of Oxford in 2017 and held postdoctoral appointments at the University of Oxford and the University of Vienna. She was awarded an ARC DECRA fellowship and moved to the University of Sydney in 2023 before joining the University of Queensland later that year. Her research focuses on computational materials physics, combining first-principles materials 76odelling methods and machine learning to understand and predict the properties of functional materials for next-generation devices and quantum technologies.

Dr. Jodie Yuwono

Adelaide University, Australia

Day 1: 16:45-17:00, Invited Talk

Title: Computational Design of High-performance Materials for Energy Conversion and Storage

Abstract: The convergence of machine learning, computational materials and electrochemical energy conversion and storage presents great opportunities for revolutionary advance the design of new devices with targeted performances. Here, we will explore the current approaches used in computational materials to improve the performance of batteries, especially for designing new electrodes and electrolytes with high activity and durability. The tunable geometric and electronic structure approach will be specifically pursued at the interface with an objective to understand the origin of the exceptional performance, which can be further implemented in materials design strategies. Computational design approaches starting from the molecular level as well as the integration with data-driven approach are shown capable to accelerate the development of high-performance energy materials, with the successful implementation on Zn-ion and Li-ion batteries.

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Dr Jodie A. Yuwono is now an ARC DECRA Fellow at UNSW Sydney. He is an expert in computational electrochemistry, advanced materials, electrochemical energy conversion and storage, and energy sustainability. Dr Yuwono has been involved in numerous government and industrial projects, with focus on solving the decarbonisation challenges and exploring transition pathways towards net-zero economy in Australia and beyond.

Dr. Xiuwen Zhou

Centre for Materials Science, School of Chemistry and Physics, Queensland University of Technology (QUT), 2 George Street, Brisbane 4000, Australia

Day 1: 17:00-17:15, Invited Talk

Title: Quantitative calculations of the photoluminescence quantum yield of organometallic emitters

Abstract Organic light-emitting diodes (OLEDs) are widely viewed as the basis for next generation displays and lighting. However, to apply this technology widely and for it to reach its full potential, improvements in the emission efficiency and device lifetime are vital. So far, the development of blue, and especially deep blue, emitters in OLEDs has progressed rather slowly. Therefore, being able to predict the emission efficiency prior to the synthesis and measurement of properties is of crucial importance for the discovery of new highly efficient blue emitters.

Our work[1–2] has shown that it is possible to predict the emission efficiency through the calculation of the radiative rate and non-radiative rate using state-of-the-art computational strategies. Specifically, we find that the main non-radiative process of a series of iridium(III) complexes is the elongation or even breaking of a metal-ligand bond, and the non-radiative rate can be predicted from the energy barrier to this non-emissive state.

In this talk, I will present our advances[2] in quantitative calculations of the photoluminescent quantum yield of iridium(III) complexes using approaches based on transition state theory and their application[3,4] in the development of new highly efficient deep blue emitters for OLEDs.

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Short Bio



Dr Zhou leads the Virtual Materials Group at Queensland University of Technology (QUT), specialising in the theoretical study and design of functional materials using quantum-mechanics-based computational methods. She earned her PhD from the University of Geneva, Switzerland, developing multiscale modelling methods. She has been a Senior Lecturer in physics at QUT since 2024. Previously, she conducted research at the University of Queensland through four fellowships: a Swiss National Science Foundation Early Postdoc Fellowship (2015), Australia-APEC Women in Research Fellowship (2016), UQ Development Fellowship (2017–2019), and Australian Research Council Discovery Early Career Researcher Award (ARC DECRA, 2019–2025), supporting her independent research career.

NextGEM26

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Day 2

Tuesday, 29 September 2026

Prof. Tsutomu (Tom) Miyasaka
Toin University of Yokohama, Yokohama, Waseda University, Tokyo

Day 2: 8:30-9:05, Plenary Talk

Title: Interface engineering for durable perovskite solar cells

Abstract: Power conversion efficiency (PCE) and operational stability of halide perovskite solar cells (PSC) have been improved through molecular engineering of heterointerfaces. PSC achieved high PCE (28%) surpassing the top efficiency of crystal silicon solar cells. High photovoltage of PSCs, as the notable feature of perovskite photovoltaics, is further enhanced by interfacial engineering. All-inorganic wide bandgap perovskites (CsPbX3, X=I, Br) achieve high photovoltage of 1.4 to 1.5V by passivating the surface defects with 2,5-thiophenedicarboxylic acid [1]. Charge-transfer functionality at heterointerfaces is improved by using SAMs, which contribute to enhanced performance and stability. We designed a new device architecture in which interfaces of perovskite layer are fully functionalized with SAMs without the use of electron transport layer (ETL) and hole transport layer (HTL) [2]. The all-SAM device is a perfect bifacial device and exhibited high durability without degradation due to the stability of charge transport materials. ETL- and HTL-free devices significantly reduce material costs and improve stability. NiOx-based p-i-n type PSCs often face challenges regarding operational stability due to the properties of NiOx. We employed a carbonyl-functionalized truxene SAM to improve the structural continuity of the heterointerface. The SAM-NiOx based p-i-n device (unencapsulated) showed high operational stability exposed to ambient air and high temperature (85oC) [3]. In fabrication of inorganic devices, MXene, as a physically robust and conductive nanosheet, can replace organic charge transport materials. MXene hybridized with NiOx serves as stable HTL. A p-i-n type PSC using a HTL composed of NiOx/MXene/SAM achieves power conversion efficiency >26%, showing high operational stability at 85°C and under 1 SUN light exposure (>2000 h) [4]. Using boron-intercalated MXene as a hole-selective material not combined with NiOx, PSCs also work with durable stability under exposure to high humidity (60% RH) showing 90% retention for 2100 h. Moisture-resistant PSCs can also be designed by modifying the interface with hydrophobic organic and dopant-free HTLs. Our n-i-p type device with a unique doner-accepter triazine derivative as dopant-free HTL shows operational stability over 2500 h in ambient air [5]. Research progresses on improving device durability through interfacial molecular engineering will be introduced.

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Completed the Graduate School of Engineering at the University of Tokyo in 1981 (PhD in Engineering). After serving as a senior researcher at Fuji Photo Film Co., Ltd., he became a professor at the Graduate School of Engineering at Toin University of Yokohama in 2001. From 2005 to 2010, he was a visiting professor at the Graduate School of Arts and Sciences at the University of Tokyo. In 2004, he founded Peccell Technologies Inc. as CEO. His research specializes in photoelectrochemistry and hybrid photovoltaic cells, especially perovskite solar cells. Awards include Kyoto Prize (2026), NIMS Award (2025), Japan Academy Prize (2024), Rank Prize (2022), Japan Society of Applied Physics Achievement Award (2019), Chemical Society of Japan Award (2017), Clarivate Analytics Citation Laureate (2017), etc.

Prof. ShiZhang Qiao
Adelaide University, Australia

Day 2: 9:05-9:40, Plenary Talk

Title: Electrocatalysis for Energy Conversion and Storage

Abstract: Powered by renewable electricity (e.g., solar, wind and hydro power), oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) can efficiently split water into green hydrogen. A crucial step in realizing this prospect is the knowledge-guided design of optimal electrocatalysts with high activity and selectivity. In this presentation, I will talk about our recent progress in mechanism understanding and material innovation for electrocatalytic water/seawater splitting for green hydrogen production. Aqueous zinc-based batteries (AZBs) and metal-sulphur batteries (MSBs) hold significant potential for energy storage due to their low cost, high safety, impressive energy density, and environmental friendliness. However, they face major challenges for commercialization, including the lack of advanced cathode materials for AZBs and slow reaction kinetics for MSBs. For AZBs, I will introduce our latest advancements that demonstrate the exceptional durability of Zn-I2 batteries in industrial-scale pouch cells, which are operated under conditions of high active mass loading for cathodes and limited Zn supply for anodes. For MSBs, I will introduce our recent research progress on developing fundamental designing principal of nanocomposite catalysts capable of enabling high-power performance in Li||S battery systems.

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Biography: Dr. Shizhang Qiao is a Chair Professor at Adelaide University, Australia. His research expertise is in nanostructured materials for new energy technologies (electrocatalysis, batteries, etc). He has co-authored more than 630 papers in refereed journals with 167,000 citations and an h-index of 210. Dr Qiao was honoured with ARC Industry Laureate Fellow, Australian Laureate Fellow. He is an elected Fellow of Australian Academy of Science (FAA), Fellow of Australian Academy of Technological Sciences & Engineering (FTSE), and a Clarivate Analytics Highly Cited Researcher in three categories of Chemistry, Materials Science, Environment and Ecology.

Room 1: Catalyst 4

Prof. Lei Ge
University of Southern Queensland, Australia

Day 2: 10:40-11:00, Keynote Talk

Title: Forced convective mass transfer by designing flow-through microtubular gas diffusion electrodes for high-rate gas-phase electrolysis

Abstract: Electrolysis of small gaseous molecules (e.g., CO2, CO, O2, NO) into value-added products and the storage of renewable electricity have drawn growing attention due to their zero-emission processes and ability to operate under ambient conditions. In addition to effective electrocatalyst design, the electrode's design and configuration are crucial for enhancing mass transport and accelerating reaction kinetics. Traditional planar electrodes suffer from low solubility of reactive gas and limited mass transportation when gas is bubbled into the catholyte. Recently, porous metallic hollow fibre gas diffusion electrodes (HFGDEs) with small radial dimensions have been emerging for the application of electrolysis due to several merits, such as a high specific surface-to-volume ratio, ease of fabrication, tailoring features, etc. This work covers our recent design and fabrication of metallic Hollow fibre GDEs (HFGDEs). We focus on the design strategies and modelling for enhancing CO2 mass transfer and supplying enriched reactant to the microenvironment. Those methods have been applied in electrochemical CO2 reduction reaction (CO2RR) to improve product selectivity, performance stability, surface wettability, and boost current density. The microtubular GDE configuration has also been extended to electrochemical CO reduction reaction, electrochemical C-N coupling and hydrogen peroxide electrochemical synthesis.

Keywords: Gas diffusion electrode, mass transfer, hollow fibre, electrolysis



Biography: I am a current ARC Future Fellow and Professor in the School of Science, Engineering and Digital Technologies and Centre for Future Materials (CFM) at the University of Southern Queensland (UniSQ). I am currently leading a research team “Gas Processing Technology and Materials” within CFM on multiple ARC and industrial projects. My research has been focused on material development for gas processing by membrane/adsorption, catalysis (e.g. CO2RR and fuel cell cathodes) and engineering design for addressing the challenges in Australian unconventional gas extraction.

Dr. Haoxin Mai
RMIT University, Australia

Day 2: 11:00-11:15, Invited Talk

Title: Design and synthesis of C3N4-based photocatalysts for energy and environmental applications

Abstract: The growing demand for energy has led to serious issues such as air pollution and climate change, impacting both human health and the environment.[1,2] This highlights the urgent need for highly efficient, green, and sustainable technologies for energy conversion and environmental remediation. Photocatalytic processes offer a promising solution by converting solar energy into chemical energy to produce eco-friendly fuels, enable green chemical synthesis, convert CO_2 into fuels and food, and purify air and water.[1,2] Therefore, developing photocatalysts that are efficient, stable, and cost-effective is essential. As a metal-free photocatalyst, carbon nitride (C_3N_4) is an excellent candidate for visible-light applications due to its suitable band gap, physicochemical stability, earth abundance, and non-toxicity. In this study, guided by theoretical modelling, C_3N_4-based materials were designed and synthesized for hydrogen production, green chemical synthesis, and pollutant degradation.[3-5] This work demonstrates the integration of theoretical calculations with material synthesis and provides a new strategy for the design and development of advanced photocatalysts for broader applications.

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Dr. Hangjuan Ren
Monash University, Australia

Day 2: 11:15-11:30, Invited Talk

Title: From Active Sites to an Active-Site Ecosystem: Rethinking CO2 Electrolysis

Abstract: Electrochemical carbon dioxide reduction (CO_2R) offers a promising route to convert CO_2 into fuels and chemicals using renewable electricity. However, the formation of high-value multi-carbon products is typically accompanied by hydrogen and diverse carbon-containing by-products, leading to poor selectivity and high downstream separation costs. Despite extensive efforts to guide catalyst design through mechanistic understanding, interpretations of CO_2R mechanisms remain fragmented and often contradictory. This challenge reflects a deeper conceptual limitation: under operating conditions, catalytic behavior emerges from the coupled evolution of heterogeneous active sites, their interactions, and dynamic local microenvironments, yet these elements are still commonly studied in isolation. Here we introduce the Active-Site Ecosystem, defined as the dynamic, coupled system formed by catalytic active sites and their surrounding microenvironments under reaction conditions. We outline two complementary toolkits for interrogating Active-Site Ecosystems: *in-situ* and *operando* characterization techniques to resolve ecosystem dynamics, and computational-based approaches that integrate heterogeneous data to construct coherent ecosystem-level representations. This ecosystem-level framework establishes a general paradigm for understanding and designing selective catalysts beyond CO_2 reduction.

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Biography: Dr. Hangjuan Ren is a Lecturer in the School of Chemistry at Monash University. She completed her PhD in Materials Science and Engineering at the UNSW Sydney. She then served as a Research Fellow at the Cambridge CARES Lab, contributing to a collaborative project between the University of Cambridge and the University of California, Berkeley. Dr. Ren further advanced her research career as a Research Associate at the University of Oxford. Her research focuses on electrocatalysis, with a particular emphasis on operando and in situ characterisation to understand reaction mechanisms and guide catalyst design for sustainable energy conversion.

Assoc. Prof. Edmund Chun Ming Tse
University of Hong Kong, HK

Day 2: 11:30-11:45, Invited Talk

Title: Hybrid Electrocatalytic Interfaces Tailored for Renewable Energy Conversion and Waste-to-Resource Upcycling

Abstract: Overcoming challenges in electrocatalysis is key to realizing a sustainable society in the future powered by renewable energy sources. Despite decades of efforts, lowering the overpotential, increasing the activity, improving the selectivity, and enhancing the stability have been difficult to achieve simultaneously. In this talk, I will discuss our strategy to facilitate energy catalysis through the development of nature-inspired electrochemical interfaces. (i) Hybrid bilayer metallomembrane (HBM) tailors the PCET processes of O_2 reduction at the electrocatalyst microenvironment.[1] (ii) Mechanical interlocking metal complexes capture the co-conformation dynamics of enzyme backbones to switch the O_2 binding mode from side-on to end-on and elongate the O–O bond for efficient cleavage.[2] (iii) Mechanical interlocking allows the installation of cationic prosthetic groups in the ligand framework and overcomes the repulsion of charged groups for efficient NO_3-to-NH_3 upcycling.[3] (iv) Cu and Co in layered double hydroxides (LDHs) cooperatively facilitate nitrate adsorption and generate ammonia with close to 100% Faradaic efficiency.[4] (v) Expansion of the interlayer spacing of LDHs and metal-doping of nanosheets enable electrochemical domino C=N bond formation for formaldoxime generation in aqueous media.[5][6]

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Prof. Edmund Chun Ming Tse currently serves as an Associate Professor in the Department of Chemistry and the Assistant Dean for the Faculty of Science at The University of Hong Kong. Prof. Tse's research operates at the cutting edge of electrocatalysis, self-assembling interfaces, and sustainable nanomaterials, where he focuses on developing innovative platforms for energy conversion and the green valorization of waste materials. He earned his B.Sc. in Chemistry from the University of Virginia in 2011, followed by a Ph.D. in Chemistry from the University of Illinois at Urbana-Champaign in 2016. He completed his subsequent training as a Postdoctoral Fellow at the California Institute of Technology from 2016 to 2018 before he joined HKU.

As a pioneer in multi-proton multi-electron redox electrocatalysis, Prof. Tse investigates enzyme-inspired systems to design sustainable chemical alternatives to fossil-fuel-dependent processes. His laboratory has delivered major scientific breakthroughs in interfacial functionalization for scalable electrosynthesis, selective nitrate-to-ammonia conversion, and the control of complex proton-coupled electron transfer pathways. This prolific research program has generated 70+ publications in high-impact journals such as *JACS*, *Angew. Chem.*, and *Nat. Mater*. He has secured competitive grants as a PI from RGC, NSFC, and SZSTI. He is equally committed to professional leadership and institutional service, serving as an Editorial Advisory Board Member for *SmartMat*, *eScience*, and *ACS Electrochem*. Prof. Tse also actively drives technology transfer and commercialization, successfully launching a start-up venture supported by TSSSU and ITSP from ITC.

Dr. Haijiao Lu
The University of Queensland

Day 2: 12:10-12:25, Invited Talk

Title: Atomic-Scale Engineering of Catalysts for Low-Carbon Energy Conversion

Abstract: Catalytic materials are essential for enabling low-carbon energy conversion and sustainable chemical processes. This work investigates nanostructured, single-atom, and defect-engineered catalysts for reactions relevant to CO2 utilisation and green hydrogen production. Particular attention is paid to the role of atomic coordination environments, interfacial structures, and oxygen vacancies in governing reaction pathways, product selectivity, and catalytic stability. Catalyst structure-performance relationships are established using a combination of controlled materials synthesis and in situ/operando characterisation techniques, including synchrotron-based X-ray absorption and in-situ electron paramagnetic resonance spectroscopy. The results demonstrate how targeted manipulation of active sites and catalyst interfaces enables improved efficiency under mild conditions. These findings contribute mechanistic understanding and practical design guidelines for developing scalable catalytic systems for carbon-neutral energy technologies and circular chemical manufacturing.



Dr. Haijiao Lu is an ARC DECRA Research Fellow in the School of Chemical Engineering at The University of Queensland, Australia. Her research focuses on photocatalytic and photothermal catalytic conversion of CO_2 into value-added fuels and chemicals, integrating catalyst design, mechanistic studies, and reaction engineering. She obtained her PhD from Tianjin University and was a visiting PhD at the University of Cambridge, followed by postdoctoral appointments at the Australian National University and The University of Queensland. Dr. Lu has authored over 70 peer-reviewed publications and has secured competitive research funding from the Australian Research Council, Department of Education (Australia), and other national and international funding schemes. She was named a Nanoscale Emerging Investigator in 2025.

Room #2: Solar 4

Prof. Satoshi Uchida

The University of Tokyo, Japan

Day 2: 10:40-11:00, Keynote Talk

Title: Beyond perovskite solar cell ~AgBiS2~

Abstract: $AgBiS_2$ is a very promising non-toxic semiconductor for the next generation of photovoltaic technology due to its favorable physical properties, earth-abundant elements, and compatibility with low-cost solution processing. In our previous work, we demonstrated that efficient $AgBiS_2$ solar cells can be successfully prepared through a direct solution-crystallized thin film onto substrates the same as those used for perovskite solar cells, yielding devices with PCE of up to 5.5 % [1]. While these results confirmed the feasibility of producing functional devices through a simple and scalable process, their performance remains limited by surface defects and interfaces, which limit efficient carrier extraction. To address these challenges, we developed a simple, effective surface engineering strategy to improve the photovoltaic performance of solution-crystallized $AgBiS_2$ [2]. By combining ultraviolet–ozone (UVO_3) treatment followed by water rinsing (UVO_3_water), we successfully reduced surface defects, optimized the $AgBiS_2$/P3HT interface, and significantly enhanced charge extraction without changing the bulk properties. Surface analysis indicates that the treatment induces $AgBiS_2$ surface reconstruction by removing residual organic contaminants and introduces oxygen-containing species such as S-O and Bi–O-rich species. As a result, the optimized devices exhibit simultaneous improvements in all photovoltaic parameters, achieving an exceptional current density close to 40 $mA \cdot cm^{-2}$ and a PCE of 6.8%, higher than our previously reported results. Furthermore, unencapsulated devices exhibit remarkable operational stability, retaining 91% of their initial efficiency after 300 hours of continuous 1Sun illumination at maximum power point tracking and 90% after 300 hours of accelerated thermal aging at 85°C. These results demonstrate that simple surface passivation is an efficient strategy for unlocking the full potential of solution-processed $AgBiS_2$ solar cells by simultaneously enhancing efficiency and long-term operational stability. This work further highlights $AgBiS_2$ as an attractive next-generation absorber material for future photovoltaic technologies in both terrestrial energy harvesting and emerging space power applications.

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Keywords: perovskite, solar cells, $AgBiS_2$, wet process



Biography: Satoshi Uchida (born in 1965) is a **Professor** at the Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Japan. He received his Ph.D. in Applied Chemistry from the Graduate School of Engineering, Tohoku University, in 1995. From 1991 to 1996, he served as a Research Associate at Tohoku University, where he was affiliated with the Research Institute of Mineral Dressing and Metallurgy (SENKEN), the Institute for Advanced Materials Processing (IAMP), the Institute for Chemical Reaction Science (ICRS), and the Institute of Multidisciplinary Research for Advanced Materials (IMRAM). He subsequently joined the Research Center for Advanced Science and Technology (RCAST) at The University of Tokyo, where he has been engaged in photovoltaic research and has served as a Research Professor since May 2017.

Research Interests: Professor Uchida has more than 30 years of research and engineering experience in nano-enabled organic photovoltaics. In the field of dye-sensitized solar cells (DSCs), he developed a series of high-performance organic indoline dye molecules and was among the first to demonstrate power conversion efficiencies exceeding 10%. He also pioneered lightweight, flexible, and full-plastic photovoltaic devices as ubiquitous power sources. His current research focuses on perovskite solar cells (PSCs), with particular emphasis on crystallography, surface and interface engineering, and electronic device simulation. His recent fundamental studies have provided new insight into one of the longstanding mysteries of perovskite solar cells—the pronounced current–voltage (I–V) hysteresis—by demonstrating that it originates from the exceptionally large junction capacitance at the TiO_2/perovskite interface. His research aims to establish a comprehensive scientific understanding of high-efficiency, stable, and scalable next-generation photovoltaic devices.

Prof. Udo Bach
Monash University, Australia

Day 2: 11:00-11:20, Keynote Talk

Title: Closing the Loop: Autonomous Robotic Discovery of Stable Inorganic Photovoltaic Absorbers

Abstract: Silicon photovoltaics are approaching practical single-junction efficiency limits, motivating the development of tandem architectures in which silicon is paired with an additional absorber. Lead halide perovskites have demonstrated strong performance in this role, but concerns related to stability and toxicity have prompted the search for alternative materials. Inorganic, solution-processable absorbers offer a promising pathway toward stable and scalable tandem photovoltaics, yet with billions of possible inorganic compounds and only a small fraction ever explored, efficient discovery tools are essential. In this talk, I will present our autonomous materials discovery platform, APEx, which accelerates the identification of such absorbers by integrating robotic ink formulation, thin-film fabrication, and automated structural, optical, and electronic characterisation into a closed-loop workflow. Materials exploration begins with automated preparation and deposition of precursor inks spanning targeted regions of inorganic chemical space. Thin films are subsequently characterised to assess crystallinity, optical absorption, and key electronic properties relevant to photovoltaic performance, including through a workflow-integrated time-resolved microwave photoconductivity setup that provides charge-carrier mobility and lifetime, allowing unpromising candidates to be efficiently screened out and experimental effort focused on the most promising materials. By operating autonomously with minimal human intervention, the platform enables sustained exploration of large design spaces that would be impractical using manual approaches, while standardising fabrication and measurement conditions to improve comparability across experiments. I will show how this approach will be used to identify promising lead-free perovskite analogues and discuss our ongoing efforts to combine this platform with machine learning to further accelerate materials discovery.



Udo Bach is a Professor at Monash University and the Monash Node Leader of the Australian Centre for Advanced Photovoltaics. He received his PhD from the Swiss Federal Institute of Technology, Switzerland, under Prof. Michael Grätzel, then worked three years in a technology start-up in Dublin, Ireland, and a postdoctoral year with Prof. Paul Alivisatos at UC Berkeley, USA, before moving to Monash University in November 2005 to establish his own research group. He has a strong background in photovoltaics and a strong interest in lab automation and AI-guided materials discovery, with research spanning perovskite and other solution-processable semiconductors.

Prof. Tao Chen
University of Science and Technology of China, China

Day 2: 11:20-11:40, Keynote Talk

Title: Chemical synthesis of antimony selenosulfide thin film for solar cell applications

Abstract: Antimony selenosulfide, $Sb_2(S,Se)_3$, is a kind of emerging solar cell material with suitable band gap (1.1-1.8 eV), high stability and abundant element storage. According to the Shockley-Queisser (SQ) limit, power conversion efficiency of the solar cell can reach 33%. More importantly, the unique one-dimensional crystal structure allows certain flexibility in the device applications. As an emerging solar cell material, the basic challenge in this field to synthesize high quality thin film for device construction. In this talk, I will present the hydrothermal deposition route for synthesizing antimony selenosulfide thin films developed in our group.[1] I will mainly discuss how this synthesis approach modulates the film's point defects, crystallization behavior and optoelectronic performance.[2-4] Based on the as-prepared films, I will also introduce our fabricated solar cells with new planar heterojunction and internal homojunction architectures.[5-7] Benefiting from optimized film deposition and rational device design, we have broken the 10% efficiency bottleneck for this emerging antimony-based photovoltaic technology.

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Professor Tao Chen is a Full Professor at the University of Science and Technology of China. His research centers on inorganic thin-film solar cells. His research group pioneered a hydrothermal deposition technique to fabricate antimony selenosulfide thin films for photovoltaic applications, breaking the long-standing 10% power conversion efficiency bottleneck of this material system.
Professor Chen has authored over 230 peer-reviewed articles in high-impact journals including *Nature Energy*, *Nature Photonics*, *Accounts of Chemical Research*, *Nature Communications*, *Advanced Materials*, *Angewandte Chemie International Edition*, etc. He was elected a Fellow of the Royal Society of Chemistry (FRSC) in 2026.

Dr. Jincheol Kim
Macquarie University, Australia

Day 2: 11:40-11:55, Invited Talk

Title: Advanced Manufacturing Strategies for Scalable Perovskite Solar Cells

Abstract: The transition of perovskite solar cells from laboratory-scale demonstrations to practical photovoltaic technologies requires advanced manufacturing strategies that integrate efficiency, stability, reproducibility and sustainability. This work presents a manufacturing-oriented approach to perovskite solar cell development, focusing on how materials chemistry, process design, characterisation and data-driven optimisation can be combined to improve device performance and manufacturability. Rather than treating materials development, device fabrication and performance analysis as separate steps, this approach links them within a unified framework for understanding and controlling the key factors that govern film formation, interfacial quality, process reliability and long-term stability. Particular emphasis is placed on sustainable solution processing, scalable fabrication and process-aware characterisation as essential components of next-generation perovskite manufacturing. Advanced analytical methods provide feedback on material quality, device behaviour and degradation pathways, while machine-learning-assisted analysis offers new opportunities to accelerate optimisation, identify critical processing parameters and strengthen process control. By connecting fundamental materials understanding with practical manufacturing requirements, this work highlights how advanced manufacturing can support the development of high-performance, reliable and scalable perovskite photovoltaic technologies.



Dr. Jincheol Kim is a Research Fellow at Macquarie University's School of Engineering and a Visiting Fellow at UNSW's School of Materials Science and Engineering. He completed his PhD at UNSW, specialising in large area perovskite solar cells, hybrid materials and scalable thin film manufacturing, with growing focus on machine learning for photovoltaic prediction and materials optimisation. He currently leads a commercialisation project on green solvent based perovskite modules, having previously led tandem device development at the Korea Electronics Technology Institute. He drives Korea Australia collaborative research and contributes to national research programs, bridging materials science and data driven methods.

Dr. Zhipeng Shao
UNSW Sydney, Australia

Day 2: 11:55-12:10, Invited Talk

Title: Li_2SnS_3 Interphase-Regulated Selenization Kinetics for High-Efficiency ACZTSSe Solar Cells

Abstract: This work reports a novel strategy for enhancing the performance of Ag-alloyed $Cu_2ZnSn(S,Se)_4$ (ACZTSSe) thin-film solar cells by introducing a Li_2SnS_3 interfacial phase to regulate the selenization reaction kinetics. It is found that during conventional selenization, the migration barriers of Sn^{4+} and Zn^{2+} in the $Cu_2Sn(S,Se)_3$ intermediate phase differ significantly, which hinders Zn^{2+} migration, causes an imbalance in the Sn/Zn ratio, and consequently induces deep-level defects (e.g., Sn_{Zn} antisites) and restricts grain growth. To address this, we spin-coat a Li_2ZnSnS_4 (LZTS) solution onto the surface of an Ag-alloyed CZTS precursor film, forming an in-situ Li_2SnS_3 interfacial phase. This interfacial phase markedly narrows the migration barrier difference between Sn^{4+} and Zn^{2+}, thereby balancing elemental migration, suppressing Zn/Sn exchange, and slowing the early-stage selenization reaction rate. Experimental results demonstrate that the Li_2SnS_3 interfacial phase effectively promotes the formation of larger and more uniform ACZTSSe grains while significantly reducing defect densities in both the bulk and at interfaces. Consequently, the solar cells fabricated with this strategy achieve an improved open-circuit voltage (V_{oc}) from 556 mV to 602 mV, a champion device efficiency of 15.45%, and a certified efficiency of 15.04%.

Lahiru Nimantha Jayasekera Gamage
Queensland University of Technology, Australia

Day 2: 12:10-12:22, Oral Talk

Title: Design of Sustainable Solvent Systems for Metal Halide Perovskite Photovoltaics

Abstract: Following their introduction to photovoltaics in 2009 with a 3.8% efficiency[1], metal halide perovskites have rapidly evolved to a record single-junction cell efficiency of 28%. This progress is driven by favourable properties, including direct bandgaps ideal for visible light absorption, bandgap tuneability, long charge-carrier diffusion lengths, low-cost solution processability, and high defect tolerance[2]. However, widespread commercialisation is severely hindered by the reliance on highly hazardous polar aprotic solvents during fabrication[3]. While greener alternative solvents demonstrate significant promise, current selection methods depend largely on empirical descriptors such as the Gutmann donor number. This conventional approach is fundamentally flawed as it fails to capture critical steric effects, binding persistence and the evolution of solvated intermediate phases prior to crystallisation[4].

To address this limitation, this research establishes a predictive computational-experimental framework to rationally design sustainable solvent systems. Computationally, density functional theory is employed to calculate electronic descriptors, binding energetics, and preferred coordination motifs between proposed green solvents and lead-halide complexes. These theoretical models are supplemented with physical experimental screening to evaluate solvent coordination behaviour. This study systematically links these computationally derived descriptors to crystallisation dynamics by experimentally tracking intermediate phase lifetimes and transformation pathways. High-speed optical and optoelectronic characterisations are utilised to monitor nucleation, growth fronts, and defect-related quenching as the films form.

This integrated methodology further evaluates how residual solvent coordination and steric profiles influence optoelectronic defect formation and moisture resistance within the final crystallised films. Ultimately, this framework will forward-predict optimal, non-toxic solvent systems that match or exceed the film quality of benchmark traditional solvents. The most viable candidates will undergo rigorous device-level validation through macroscopic drift-diffusion simulations and the physical fabrication of full solar cell devices, paving the way for safer, regulatory-compliant commercialisation of perovskite photovoltaics.

Keywords: Metal Halide Perovskites, Sustainable Solvent Systems, Density Functional Theory, Solvated Intermediate Phases

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Room 3: Battery 3

Assoc. Prof. Nolene Byrne

Deakin University, Burwood, Victoria 3125, Australia

Day 2: 11:00-11:20, Keynote Talk

Title: Development of high-performance hard carbon anode active materials: exploring property-structure-processing-performance

Abstract: Energy storage devices are a critical component in the transition to clean energy. The limitations associated with Lithium-ion batteries (LIB) such as the supply volatility, cost and the inherent safety issues can largely be overcome by sodium ion batteries (SIB). SIBs and LIBs share many similarities and many of the learnings from LIB technology can be applied to SIBs resulting in potentially a fast transition to market for SIBs. However, unlike LIB batteries, which require highly structured graphite as the anode, Na-ion perform best with carbon anodes which are non-graphitizable termed hard carbons. Hard carbons can be synthesis from a wide variety of feedstock and via a number of different heating protocols. In recent times, hard carbons from waste streams, such as waste biomass, have gained some interest however despite the precursor choice some inherent limitations remain for hard carbons such as low initial columbic efficiency and rate capability limitations. In this talk we explore how the choice of precursors, conversion process used, temperature, atmosphere, time, rate, electrolyte and pre sodiation influence electrochemical performance drawing some conclusions on the role of the solid electrolyte interphase and the bulk material properties of the hard carbon on sodium storage mechanism and overall electrochemical performance.



Associate Professor Nolene Byrne is a researcher at Deakin University Institute for Frontier Materials whose work focuses on developing advanced materials for next-generation energy storage systems. Her research investigates sustainable carbon anodes, ionic liquid electrolytes, and electrode–electrolyte interfaces for sodium-ion and lithium-ion batteries. She combines materials synthesis with advanced characterisation to understand battery degradation and improve performance, safety, and lifetime. Her research supports the development of high-performance, sustainable battery technologies for renewable energy storage and electrification.

Assoc. Prof. Cheng Zhang
The University of Queensland, Australia

Day 2: 11:20-11:40, Keynote Talk

Title: Fluorination in Advanced Battery Design

Abstract: Polymers are a key element of rechargeable battery technology, serving as electrode binders, electrolyte additives, and separators. A long-standing "grand challenge" in polymer science is the preparation of materials with precisely defined compositions, architectures, structures, and functions.[1] In this presentation, I will discuss the design and synthesis of a series of well-defined fluorinated polymers used as electrolyte additives, solid-state electrolytes, and electrode coatings to enhance battery performance.[2-4] The key to success lies in promoting the formation of stable fluoride interfaces, which prevent dendrite growth, reduce electrolyte consumption, and improve battery cycling stability and capacity retention.[5] To conclude, I will also address current regulations on fluorinated compounds (PFAS) and how they present both challenges and new opportunities in battery researches.

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Assoc. Prof. Bing Sun
University of Technology Sydney, Australia

Day 2: 11:40-11:55, Keynote Talk

Title: Interphase and Interface Design for High-Energy Lithium Metal Batteries

Abstract: Owing to their ultrahigh theoretical specific capacity and the lowest electrochemical potential, lithium metal anodes are widely regarded as the ultimate anode for next-generation high-energy-density rechargeable batteries. However, their practical application remains hindered by uncontrolled dendrite growth, continuous parasitic reactions, unstable solid electrolyte interphases (SEIs), and large volume fluctuations during repeated lithium plating and stripping, resulting in poor Coulombic efficiency, limited cycling stability, and serious safety concerns. Herein, we will introduce our recent advances in interphase and interface engineering for durable lithium metal anodes through the rational regulation of lithium nucleation, ion transport, and interfacial chemistry. First, we demonstrate that controlling lithium nucleation behaviour through temperature-dependent deposition enables compact and dendrite-free lithium growth by promoting lithiophilicity and accelerating Li-ion diffusion. We further present a bio-inspired "self-immunization" strategy, in which protein molecules undergo adaptive secondary-structure transformation to selectively adsorb onto lithium protrusions, dynamically regulating local electric fields and suppressing dendrite propagation. Building upon interface regulation, we develop multifunctional three-dimensional cationic metal–organic framework current collectors that combine hierarchical porous architectures with positively charged lithiophilic surfaces to homogenize lithium-ion flux while simultaneously inducing the formation of robust LiF/Li_3N-rich SEIs for long-term cycling stability. Finally, we introduce a Geomag-inspired dynamically reconfigurable molecular interphase based on polyhedral oligomeric silsesquioxane, where reversible hydrogen-bonded junctions create a stress-adaptive, self-healing SEI capable of autonomously reconstructing lithium-ion transport pathways and accommodating repeated volume changes without mechanical fatigue.

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Dr Bing Sun is an Associate Professor at University of Technology Sydney (UTS). His research focuses on the development of next-generation rechargeable batteries and interface engineering of functional materials for energy-storage and biomedical applications. He has published more than 140 peer-reviewed papers in leading journals, including *Nature Energy*, *Nature Communications*, *Science Advances*, *Joule*, *Advanced Materials*, and *Angewandte Chemie International Edition*, with over 17,000 citations and an h-index of 75. He was recognised as a Clarivate Highly Cited Researcher in 2025. Dr Sun has received multiple Australian Research Council (ARC)-funded projects and fellowships, including the ARC DECRA and ARC Future Fellowship.

Dr. Tianyi Wang
Centre for Clean Energy Technology, School of Mathematical & Physical Sciences, Faculty of Science, University of Technology Sydney

Day 2: 11:40-11:55, Invited Talk

Title: Biomolecule-Regulated Interfaces for Rechargeable Metal Batteries: From Dynamic Interphases to Biomimetic Mineralization

Abstract: Metal anodes offer compelling opportunities for next-generation rechargeable batteries because of their high theoretical capacities and low electrochemical potentials. However, their practical implementation remains hindered by non-uniform ion transport, unstable interfacial chemistry, parasitic reactions, and uncontrolled metal deposition. Nature provides sophisticated strategies for regulating ion transport and mineral growth through biomolecular recognition, dynamic interactions, and hierarchical self-assembly.

In this presentation, we will discuss our recent efforts to employ biomolecules and biomimetic principles to regulate metal–electrolyte interfaces for advanced energy-storage systems. Biomacromolecules containing abundant functional groups can interact dynamically with metal ions and electrode surfaces, enabling regulation of ion solvation, interfacial adsorption, nucleation, and subsequent metal growth. Such bio-inspired interfacial engineering provides an effective route toward highly reversible metal deposition while suppressing dendritic growth and undesirable side reactions. Beyond direct molecular regulation, we further extend this concept toward biomimetic mineralization, in which protein conformational changes and confined interfacial environments are exploited to guide the directional assembly and growth of functional inorganic architectures. These ordered bio-inorganic interfaces provide well-defined ion-transport pathways and redistribute local ionic flux, offering a new approach to stabilizing highly reactive metal anodes.

Together, these studies demonstrate how biological molecules can move beyond conventional electrolyte additives or coatings and serve as programmable building blocks for constructing adaptive, hierarchical, and ion-selective interfaces. Such biomolecule-enabled strategies may establish a versatile platform for designing safer and more sustainable metal batteries and other next-generation electrochemical energy-storage technologies.

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Dr Tianyi Wang is an ARC Discovery Early Career Researcher Award (DECRA) Fellow at the Centre for Clean Energy Technology, University of Technology Sydney. His research focuses on bio-inspired and molecularly engineered interfaces for advanced rechargeable batteries, particularly metal anodes, biomolecular interfacial chemistry, artificial interphases, photocatalysis and biomimetic mineralization. He has published over 40 papers as first or corresponding author, including articles in *Nature Communications* (3), *Advanced Materials* (3), *Angewandte Chemie International Edition* (5), *Advanced Energy Materials* (2), *Electrochemical Energy Reviews*, and *Advanced Science* (4). He has an H-index of 44 and serves on the Early Career Editorial Boards of *eScience*, *Carbon Neutralization*, and *Energy Materials*. He was included in the 2025 Stanford University–Elsevier World's Top 2 % Scientists list.

Dr. Tong Yang
Queensland University of Technology, Australia

Day 2: 11:55-12:07, Oral Talk

Title: Ultra-Thin Hybrid Ion Exchange Interlayer for High Performance Aqueous Zn Metal Batteries

Abstract: The application of aqueous zinc metal batteries (AZMBs) is limited by the poor cycling stability and undesired dendritic growth of Zn anodes. Herein, a Zn anode with an ultra-thin sulfonated poly(ether ether ketone) (SPEEK) and fluorinated carbon dots (FCDs) hybrid interlayer is developed to enhance AZMBs performance. The SPEEK/FCD interlayer possesses excellent stability and is found to play multiple functions, including effectively regulating electrolyte solvation structure by ion-exchange groups, promoting ion transport through the ion-exchange channels of the hybrid SPEEK/FCD interlayer, inducing the in-situ formation of a stable ZnF_2-rich solid electrolyte interphase (SEI), and accommodating volume fluctuations during Zn plating/stripping cycles. As a result, at 1 mA cm^{-2} and 1 mAh cm^{-2}, Zn||Zn symmetric cells with the optimized SPEEK/FCD Zn electrode exhibit an ultralong lifespan of over 5500 h, much better than that of the bare Zn electrode (119 h). In addition, at 1 A g^{-1} after 1000 cycles, the Zn||V_2O_5 full cell with the optimized electrode retains 89.8% of its initial capacity, compared to 40.3% for the bare Zn electrode. These superior performances indicate the optimized Zn electrode is promising for next-generation AZMBs. Also, the simple and scalable method offers a valuable reference for improving the performance of other aqueous batteries and beyond.

Key Words: Aqueous zinc metal batteries; SPEEK/FCD hybrid interlayer; Zn anode stabilization; Solvation regulation; ZnF_2-rich SEI.

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Shuangbin Zhang
Queensland University of Technology, Australia

Day 2: 12:07-12:19, Oral Talk

Title: Hexacoordinate Iron Complex Anolyte for High-Performance Alkaline All-Iron Redox Flow Batteries

Abstract: Alkaline all-iron redox flow batteries (RFBs) are promising for large-scale stationary energy storage owing to their low cost, elemental abundance, environmental friendliness, and independently scalable energy and power. Compared with acidic all-iron system, alkaline chemistry provides a more favorable operating potential while mitigating side reactions associated with H_2O.[1] However, their practical development is hindered by the limited coordination stability of Fe-based anolytes. Ligand dissociation and structural degradation during long-term cycling can lead to irreversible capacity decay, highlighting the need for robust Fe coordination chemistry under strongly alkaline conditions.[2] Here, we developed a new Fe anolyte based on a rationally engineered amino-alcohol scaffold. The resulting coordinatively saturated six-coordinate Fe complex exhibits enhanced stability and enables an alkaline all-iron RFB to operate stably for over 2000 cycles with a coulombic efficiency approaching 100% and approximately 95% capacity retention.[2] These results highlight coordination engineering as an effective approach to developing stable Fe-complex anolytes for high performance alkaline all-iron RFBs.

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Room 4: Theoretical Computation and Machine Learning 2

Prof. Zhe Liu

The University of Melbourne, Australia

Day 2: 10:40-11:00, Keynote Talk

Title: Mesoscale dynamics of electrosorbed ions in fast-charging carbon-based nanoporous electrodes

Abstract: Electrosorption, the accumulation of electrolyte ions at charged interfaces, is a common phenomenon across various electrochemical systems. Its impact is particularly pronounced in nanoporous electrodes owing to their high surface-to-volume ratios. Although electrosorption alters the ion distribution at the electrode–electrolyte interface through the formation of an electrical double layer, the effects of electrosorbed ions on the charge storage dynamics in nanoporous electrodes and their ability to improve charging processes have often been overlooked. Here we use a multilayered reduced graphene oxide-based membrane as a model nanoporous electrode material, integrating numerical simulations with experimental insights. We monitor the spatiotemporal distribution of electrosorbed ions and electrical potentials across the nanopore network during fast charging of symmetrical laboratory-scale cells using aqueous and non-aqueous electrolyte solutions. This method allowed us to quantitatively assess how features of the nanoporous electrode mesostructure, such as nanoslit size, the distribution of nanoslit sizes and electrode thickness, dynamically influence ion electrosorption and the local electrical and chemical potentials across the network. Our findings reveal that the mesostructure of nanoporous electrodes influences how migration and diffusion currents, mediated by electrosorbed ions, respond to charging rates.

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Biography: Dr (Jefferson) Zhe Liu is an Australian Future Fellow, Professor of Computational Materials Engineering, and leader of the Integrated Computational Materials Engineering (ICME) consortium at The University of Melbourne. He got his bachelor and master degrees in Engineering Mechanics at Tsinghua University. He got a Ph.D. in Materials Science and Engineering at Northwestern University in the US. He then spent two years as a postdoc research fellow at the National Renewable Energy Laboratory. Dr Zhe Liu's group develops/employs ICME methods for dynamic ionic systems in electrochemical energy storage and conversion applications, which uses computational methods to translate the nanoscale ionic science to larger length scale applications by integrating digital models at different length scales, simulations with data science, and theory with experiments.

Assoc. Prof. Asaph Widmer-Cooper
University of Sydney, Sydney, Australia

Day 2: 11:00-11:20, Keynote Talk

Title: Simulation Insights into the Formation and Stability of Metal Halide Perovskites

Abstract: Metal halide perovskites (MHPs) are a promising class of materials for optoelectronic applications that are energy efficient, printable, low-cost and solution processable.[1] A key requirement for many MHP applications, including tandem solar cells, LEDs, photodetectors and lasers, is the ability to tune the material bandgap by varying the halide composition. This can be controlled at the manufacturing stage by changing the relative amounts of halide precursors in solution. In practice, however, the performance of devices made using MHPs has been limited by poor material stability as the halides phase segregate upon light exposure. This leads to localized changes in the material bandgap which in turn affect the optoelectronic properties. This effect is known as photoinduced halide-ion segregation (PHS). Understanding its origin and how to reverse it, is therefore vital to develop stable MHP devices and to promote their adoption into the market. Scaling up the manufacture of high-quality crystalline films also requires detailed understanding of how solution composition affects viscosity and of how the crystals form starting from their solvated precursors, via both one-step and two-step processes. This talk will present computational approaches we have developed to tackle these problems and insights gained from this work. This includes the development of a lattice model for studying the complex effects of light and heat on PHS,[2,3] the development of polarizable and machine learned force fields for studying the formation of MHPs from solution,[4] and the use of advanced sampling techniques to access experimentally relevant timescales and to calculate insightful free energy changes.[5,6] Recent unpublished results will also be discussed.

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A/Prof. Asaph Widmer-Cooper is a computational chemist and member of the University of Sydney Nano Institute. Working at the interface of chemistry, physics and materials science, he uses computer simulations to understand how nanomaterials form and behave. This includes work on nanoparticle interactions and assembly, crystal nucleation and growth, and the design of new materials for harnessing solar energy. A former ARC Future Fellow and CI in the ARC Centre of Excellence in Exciton Science, he is currently Theme Leader for Self-Assembled Nanomaterials at the University of Sydney and a board member of the Australasian Colloid and Interface Society.

Asst. Prof. Leonard Ng Wei Tat
National University of Singapore, Singapore

Day 2: 11:20-11:40, Invited Talk

Title: From Photovoltaics to Hydrometallurgy: Self-Driving Laboratories as a Universal Engine for Accelerated Materials Discovery

Abstract: Self-driving laboratories (SDLs) promise to fundamentally transform how we discover and scale advanced materials, yet realising that promise demands more than automating existing workflows. This talk presents our group's expanding portfolio of SDL platforms and illustrates how the paradigm generalises across vastly different materials challenges. We begin with our flagship photovoltaic work, in which an SDL-enabled roll-to-roll line fabricated perovskite solar cell modules at 11% efficiency under ambient conditions, processing over 11,800 devices in 24 hours at a projected cost of approximately 0.7 USD/W. Building on the lessons learned, we describe HYDRA, our recently funded NRF AI for Science programme that deploys a closed-loop SDL for e-waste hydrometallurgy, coupling an Opentrons Flex liquid-handling robot with Agilent ICP-OES analytics to autonomously optimise metal-recovery processes from electronic waste. We then turn to an emerging frontier: AI-guided scaffold design for cultivated meat, where data-driven optimisation of biomaterial composition and architecture is being pursued under a dedicated SFA grant. Across these domains, a common thread emerges: the evolution of SDLs from narrow optimisation engines toward autonomous systems capable of hypothesis generation, cross-domain transfer, and integration of manufacturing constraints from the outset. We discuss how this vision is supported by our broader work in AI-driven materials discovery, including the development of autonomous agents and open-source tools that aim to democratise SDL access. The talk concludes with a roadmap for next-generation SDLs and reflections on the translational pathway from laboratory discovery to commercial impact, drawing on our ongoing technology-transfer and commercialisation efforts.



Biography: Leonard Ng Wei Tat is an Assistant Professor at the School of Materials Science and Engineering, Nanyang Technological University (NTU), Singapore, a Cluster Director at the Energy Research Institute @ NTU (ERI@N), and Deputy Director of the AI for Materials Initiative (AIM). He leads the NGenuity Lab, whose research spans self-driving laboratories for accelerated materials discovery, AI-driven optimisation of perovskite and organic photovoltaics, autonomous hydrometallurgical recycling of e-waste, and biomaterial scaffold design for cultivated meat. He holds a PhD in printed electronics from the University of Cambridge and is a Member of the Royal Society of Chemistry.

Dr. Teng Lu
Australian National University, Australia

Day 2: 11:40-11:55, Invited Talk

Title: Resolving correlated disorder in polar functional materials through atomistic modelling

Abstract: Polar functional materials, particularly ferroelectrics and antiferroelectrics (FE/AFE), are essential components in modern electrical and electronic devices such as capacitors, sensors, and FeRAM. FE and AFE materials are especially attractive for high-power dielectric energy storage because their polar order can be reversibly switched under applied electric fields. [1] In these strongly correlated systems, long-range polar order can increase hysteresis and energy dissipation during charge-discharge cycles. A major strategy for suppressing this loss is to tailor polarisation through nanoscale compositional inhomogeneity arising from atomic disorder. However, stronger local heterogeneity often reduces hysteresis at the cost of induced polarisation, thereby limiting overall energy-storage performance. [2] To design high-performing dielectric energy-storage materials, it is therefore essential to establish chemistry-structure-property relationships for disordered polar structures. Yet conventional crystallography is often insensitive to the local disorder, short-range correlations and element-specific displacements that control functional response. In this work, we combine total scattering, diffuse scattering and chemistry-supervised reverse Monte Carlo (RMC) refinement to construct large atomistic models of representative polar materials. These models resolve correlated chemical disorder and local polar distortions, revealing how atomic-scale heterogeneity affects nanoscale polar states. [2–4] The resulting structural pictures and correlation-based descriptors encode element-specific interactions and quantitative links to macroscopic properties. This approach provides an atomistic basis for designing dielectric materials that balance low hysteresis with retained polarisation.

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Dr. Teng Lu earned his PhD from the Australian National University (ANU) in 2018 and continued there as a Research Fellow. He is currently an ARC DECRA fellow at ANU. His research began with polar functional materials, exploring how their structure-property relationships evolve under external stimuli, with applications in energy storage, conversion, and harvesting. He is particularly interested in complex structural analyses across various length scales and time scales using electron, neutron, and synchrotron X-ray scattering techniques. His work also involves characterizing nanoscale functionalities through scanning probe microscopy (SPM) techniques and developing new methods to map local properties.

Ahmad Ayyaz
Queensland University of Technology, Australia

Day 2: 12:10-12:25, Oral Talk

Title: Impact of Australian sourced precursor impurities on halide perovskite solar cells performance: DFT and Experimentation

Abstract: Inorganic metal halide perovskite $CsPbI_3$-based solar cells have shown tremendous progress recently; however, the device performance reported to date remains limited[1]. The purity of perovskite precursor is critical for the properties and stability of $CsPbI_3$-based solar cells. The current work systematically studies the effects of various precursor impurity concentrations on the material properties and device performance[2]. The stability, electronic structure, transition energy levels, defect formation energy, and diffusion of precursor impurities, such as Fe^{3+}, Ca^{2+}, Na^{+}, and K^{+} in $CsPbI_3$ are comprehensively studied using density functional theory (DFT) calculations[3]. Phonon dispersion and ab initio molecular dynamics (AIMD) simulation confirm thermodynamic stability of $CsPbI_3$. Our findings demonstrate that Ca and K impurities exhibit negligible impact on $CsPbI_3$ because of the relatively high formation energies. Meanwhile, Fe^{3+} and Na^{+} impurities with lower formation energies and diffusion barrier can effectively diffuse in $CsPbI_3$, suggesting the significant influence on device performance. The experimental synthesis of $CsPbI_3$ using Australian sourced precursors (CsI and PbI_2) with different impurity concentrations and spin coating approach[4] is underway. Afterwards, the device fabrication will be performed to analyse the photovoltaic performance of devices fabricated with both low and high impurity precursors. This study establishes precursor purity as a key determinant of solar cell efficiency and stability, offering insights into the advancement of stable and efficient photovoltaic devices. Our work highlights the distinct behaviors of precursor impurities in $CsPbI_3$ and their influence on the related devices and identified precursor purity as a critical factor in the performance of $CsPbI_3$-based solar cells and thus provide insights into further advancement of stable and efficient photovoltaics.

Keywords: Perovskite solar cells; Precursor impurities; DFT calculations; Synthesis of $CsPbI_3$; Device fabrication.

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Ika Fitriani
The University of Sydney, Australia

Day 2: 11:55-12:10, Oral Talk

Title: Why Metadynamics Fails to Capture Perovskite Nucleation: A Force Field Perspective

Abstract: The simulation of perovskite from methylammonium lead iodide precursor ions using conventional molecular dynamics simulation couldn't capture nucleation, motivating the use of an enhanced sampling method to access nucleation timescale. In this work, we use metadynamics simulation to bias the free-energy landscape of Pb^{2+}, I^-, and MA^+ precursor ions in acetonitrile solvent. The aim of these simulations is to drive the system towards nucleation events. Two collective variables (CVs) were defined: the coordination number of Pb^{2+} with iodide ions and coordination number of methylammonium cation around a PbI_6 octahedral unit. After running metadyamics for 1000 ns, no nucleation was observed under any sampled conditions. The failure could be due to limitations in the classical force-field description. First, the anomalous stability of the PbI_2 crystal is observed in the classical potential, leading to a disordered state that resist the structural reorganization required for nucleation. Second, the $MAPbI_3$ crystal did not dissolve in DMF and ACN solvents, even at concentrations exceeding experimental solubility limits. The insoluble crystal indicates that the force field struggles to simultaneously balance the solid-state and liquid-state. Third, the Pb-I coordination number is underestimated in the classical force field compared to Pb-I coordination number in perovskite crystal. Lower coordination number leading to unphysical starting configuration that biases the CV space away from physically relevant nucleation pathways. These results highlight fundamental limitations of the classical force field for modelling halide perovskite in polar aprotic solvents.

Keywords: metal halide perovskite, metadynamics, nucleation

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Room 5: 2D Materials 1

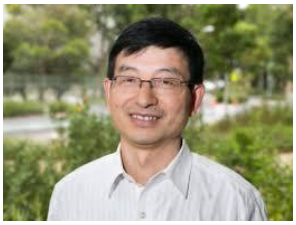
Prof. Huanting Wang

Monash University, Australia

Day 2: 10:40-11:00, Keynote Talk

Title: Nanosheet-based proton conducting membranes for fuel cells and hydrogen separation

Abstract: Ion transport is central to applications such as clean energy and environment. In particular, high-performance proton exchange membranes play a vital role in the efficiency of high-temperature proton exchange membrane fuel cells. Various types of materials such as polymers, 2D materials and advanced porous frameworks have been studied for ion-conducting membrane materials. High-temperature operation enhances the efficiency and design simplicity of electrochemical devices, but conventional polymer membranes lose proton conductivity rapidly due to dehydration. Atomically thin nanosheets can selectively transport thermal protons through nanoscale corrugations and quantum tunneling, making them promising for high-temperature proton-conducting membranes. However, stacked nanosheet assemblies often suffer from poor proton transport between layers. We built nanosheet-based membranes by bridging individual nanosheets using nanoconfined phosphoric acid. This architecture enables low-tortuosity, synergistic proton transport via both through-nanosheet conduction and hydrogen bond–mediated hopping along confined acid layers, resulting in ultrafast, stable proton conduction under anhydrous high-temperature conditions. A polyethylenimine-functionalized graphene/boron nitride bilayer membrane achieves a proton conductivity of 166 millisiemens per centimeter and delivers a power density of 1011 milliwatts per square centimeter in hydrogen fuel cells at 250°C, outperforming most previously reported anhydrous proton-conducting membranes. Furthermore, it exhibits superior methanol tolerance, achieving 502 milliwatts per square centimeter on concentrated methanol. This work offers a versatile platform for high-temperature proton-conducting membranes for electrochemical energy and hydrogen separation.



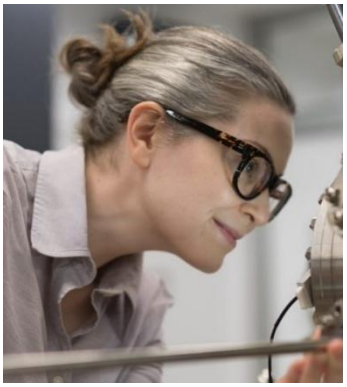
Biography: Prof Huanting Wang is a Sir John Monash Distinguished Professor in the Department of Chemical and Biological Engineering and serves as Pro Vice-Chancellor and President (Suzhou) at Monash University. Prof Wang's research focuses on nanomaterials and composite membranes for gas separation, water desalination and purification, chiral separation, ion transport and separation and electrochemical energy applications.

Prof. Jennifer MacLeod
Queensland University of Technology, Australia

Day 2: 11:00-11:20, Keynote Talk

Title: Surface-Confined Metal-Organic Architectures for Future Energy Technologies

Abstract: Surface-confined metal-organic architectures represent a versatile class of designer materials with applications spanning catalysis, energy conversion, and next-generation electronics. Through the controlled assembly of metal centres and molecular linkers, these systems can be engineered with atomic precision to create a diverse range of two-dimensional structures, from dense coordination networks to porous metal-organic frameworks. Recent advances have demonstrated the ability to tailor both chemical functionality and electronic behaviour, enabling architectures that exhibit catalytic activity, tunable charge transport, and even exotic quantum states associated with honeycomb and kagome lattices. These capabilities open new opportunities for sustainable energy technologies, including low-energy electronics, electrocatalysis, and efficient chemical transformations. This presentation will focus on our recent progress in the synthesis and characterisation of surface-confined metal-organic architectures, and how their unique combination of structural programmability and emergent functionality may contribute to future energy materials and devices



Biography: Professor Jennifer MacLeod is a physicist in the School of Chemistry and Physics at Queensland University of Technology (QUT), Australia. Her research focuses on the atomic-scale design and characterisation of low-dimensional materials, including two-dimensional metal-organic architectures, functional surfaces, and nanostructured materials for energy and electronic applications. She uses advanced surface science techniques, including scanning probe microscopy and spectroscopy, to investigate the relationships between structure, electronic properties, and functionality. Her work spans fundamental studies of emergent quantum behaviour through to the rational design of materials for catalysis, energy conversion, and sustainable technologies.

Prof. Yun Wang
Griffith University, Australia

Day 2: 11:20-11:40, Keynote Talk

Title: Engineering Mechanical Behaviour in 2D Materials for Energy and Functional Applications

Abstract: Mechanical behaviour plays a crucial role in determining the reliability and performance of two-dimensional (2D) materials in energy and functional applications. This work presents a comprehensive theoretical and multiscale investigation of MXenes, MBenes, and transition metal dichalcogenides (TMDs), focusing on understanding and tuning their mechanical response. Using density functional theory and numerical simulations, we systematically examine how surface functionalization (oxygen, hydroxyl, and halogen terminations), compositional design, and defect engineering influence mechanical properties alongside thermal and electronic characteristics. Our findings reveal that double transition metal MXenes exhibit enhanced mechanical strength and thermal stability driven by superexchange interactions, while oxygen-terminated and higher-order MXenes offer superior structural integrity. MBenes, particularly Mo_2B_2-based systems, display remarkable stiffness and unconventional auxetic behaviour, highlighting their resilience under deformation. In TMDs, we show that vacancies, phase transitions, and lateral heterostructures significantly affect mechanical behaviour while simultaneously tuning electronic properties. Multiscale simulations further bridge atomistic insights with macroscopic responses, providing a holistic understanding of deformation and stability. Importantly, we demonstrate that tailored mechanical behaviour underpins improved performance in practical applications. Mechanically robust MXenes show promise for stable CO_2 reduction catalysis, while high-fracture-toughness metal-organic polymer electrodes enable durable and fast-charging lithium-ion batteries. Overall, this work establishes general design principles for controlling mechanical behaviour in 2D materials, offering pathways to enhance their reliability and functionality in energy storage, catalysis, and other demanding environments.

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Prof. Vita Pi-Ho Hu

National Taiwan University, Taiwan

Day 2: 11:40-11:55, Invited Talk

Title: 2D Materials-Based Static Random-Access Memory

Abstract: The rapid growth of data-centric and AI-driven applications has intensified the demand for high-density, high-speed, and energy-efficient embedded memory. As on-chip SRAM caches occupy a large portion of modern computing systems, further improvements in SRAM density, stability, speed, and power efficiency are essential for next-generation technologies. This talk presents recent progress in 2D material (2DM)-based static random-access memory (SRAM), focusing on both 2D material FET-based SRAM and 3D SRAM using back-end-of-line (BEOL)-compatible 2DM transistors. First, Si- and 2D material-based SRAM circuits are compared across technology nodes from 16 nm to 1 nm using cross-level device-to-circuit simulations. The results show that 2D material FETs, enabled by their reduced parasitic capacitance, can improve SRAM read stability, write stability, operating speed, and dynamic power efficiency compared with Si-based SRAM at advanced nodes [1]. In particular, at the 1 nm node, 2D material SRAM reduces cell read access time, time-to-write, and dynamic power. Second, 3D SRAM designs integrating FEOL Si FinFETs with BEOL-compatible 2DM transistors are discussed. Two partitioning schemes, including BEOL pass-gate and BEOL pull-up transistor configurations, are analyzed through iterative electrical-thermal simulations. The optimized BEOL pull-up design achieves reduced cell area, improved write stability, and enhanced read/write speed compared with conventional Si FinFET SRAM [2]. These studies highlight the potential of 2D materials devices for future high-performance, low-power, and highly integrated memory technologies.

Keywords: 2D materials, SRAM, 3D integration, BEOL-compatible transistors, low-power memory

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Vita Pi-Ho Hu is a Professor in the Department of Electrical Engineering at National Taiwan University. She received her B.S. and Ph.D. degrees from National Chiao Tung University in 2004 and 2011. Her research focuses on ferroelectric memory, advanced nanoelectronics, SRAM, 3D ICs, and design-technology co-optimization. She has authored or co-authored more than 150 peer-reviewed publications and received numerous honors, including the Ta-You Wu Memorial Award, Outstanding Women in Science Award, and Micron Foundation Chair Professorship. Prof. Hu is also actively involved in the international technical community, serving on committees for IEDM, ISSCC, VLSI, ISQED, EDTM, ISCAS, IEEE EDS WiED, and IEEE CASS, where she serves as Chair-Elect of the Nano-Giga Technical Committee.

Prof. Vita Pi-Ho Hu
Professor
Department of Electrical Engineering
Graduate Institute of Electronics Engineering
Graduate School of Advanced Technology
National Taiwan University

Dr. Qiran Cai
Deakin University, Australia

Day 2: 11:55-12:10, Invited Talk

Title: Thermal properties and applications of boron nitride nanosheets

Abstract: As electronic devices continue to evolve toward miniaturisation and multifunctionality, overheating has become a major challenge that limits device performance, reliability, and lifespan. Addressing this issue requires materials that combine high thermal conductivity with excellent electrical insulation for efficient heat dissipation. Boron nitride nanosheets (BNNSs) are promising candidates that meet these requirements. In this presentation, we first report the in-plane thermal conductivity of atomically thin BN. Combined experimental measurements and density functional theory (DFT) calculations reveal how both layer thickness and isotopic composition influence phonon transport and thermal conductivity (1–4). Although BNNSs possess exceptional in-plane thermal conductivity, their intrinsically low cross-plane thermal conductivity results in highly anisotropic heat transport in BNNS-based composites. To address this limitation, we developed a simple and scalable mechanochemical exfoliation method to produce functionalised BNNSs with excellent dispersibility in both aqueous and organic solvents (5). These high-quality dispersions enabled the fabrication of BN spheres with high isotropic thermal conductivity. When incorporated into poly(vinyl alcohol), the BN spheres increased the composite thermal conductivity by approximately 3700%, effectively overcoming the anisotropic heat transport commonly observed in BN-reinforced polymers (6). This work provides fundamental insights into phonon transport and scattering in BNNSs while demonstrating a practical strategy for developing electrically insulating thermal interface materials with high isotropic thermal conductivity for next-generation thermal management applications.

Keywords: boron nitride, nanosheets, thermal conductivity, phonon dispersion, heat transport

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Dr Qiran Cai is an ARC DECRA Fellow at the Institute for Frontier Materials, Deakin University, Australia. His research focuses on boron nitride nanomaterials, diamond, and advanced thermal management materials. His work spans fundamental studies of phonon transport, Raman spectroscopy, and nanomaterial mechanics, as well as the development of functional materials and devices for thermal management, sensing, and energy applications. His current research includes boron nitride-based thermal interface materials, diamond heat spreaders, and diamond-based electronic devices, with an emphasis on understanding structure-property relationships and translating materials research into practical technologies.

Muhammad Sabbtain Abbas
Seoul National University, South Korea

Day 2: 12:10-12:25, Oral Talk

Title: Wafer-scale synthesis of monolayer amorphous carbon interlayer on c-Al2O3 as universal template for remote epitaxy

Abstract: Remote epitaxy enables the fabrication of freestanding single-crystalline thin films by growing epitaxial layers on substrates coated with ultrathin two-dimensional (2D) interlayers. The films inherit the substrate crystal orientation while remaining weakly bonded, allowing facile mechanical release. However, achieving high-quality epitaxy critically depends on the choice of the 2D interlayer, as its structural and chemical properties govern nucleation, growth dynamics, and film quality. In this work, we demonstrate the scalable synthesis of amorphous carbon (aC) interlayers on c-Al2O3 with precise tunable thickness down to the monolayer. Raman spectroscopy mapping, both local and wafer-scale areas confirm uniform aC coverage across 2-inch wafer, with an average ID/IG ratio 0.95. High-resolution transmission electron microscopy reveals amorphous nature of the aC, characterized by randomly arranged carbon polygons without long-range order, consistent with diffused and hollow electron diffraction pattern. X-ray photoelectron spectroscopy and electron energy loss spectroscopy reveals highly sp2 hybridized carbon content whereas Atomic force microscopy further indicates atomically smooth surface with RMS roughness of 0.15 nm.The aC-coated substrates were subsequently utilized for the growth of freestanding GaN thin films by metal-organic chemical vapor deposition (MOCVD). As compared to crystalline graphene, amorphous carbon exhibits enhanced chemical reactivity due to the presence of dangling bonds associated with randomly oriented carbon atoms, resulting in a higher nucleation density and improved film continuity. Furthermore, precise control of MOCVD growth parameters and aC quality at each stage of the process enables the reliable and facile release of GaN thin films. These findings establish amorphous carbon as a highly suitable and scalable interlayer for the remote epitaxial growth of freestanding nitride semiconductor thin films.

Plenary Session 4

Prof. Joanne Etheridge
RMIT University, Australia

Day 2: 13:25-14:00, Plenary Talk

Title: Perovskites for Sustainable Energy Applications: Which atoms matter?

Abstract: The perovskite structure (ABX_3) can manifest a variety of fascinating physical properties, from photoabsorption to ferroelectricity to superconductivity, depending on its chemical composition, temperature and/or pressure. Subtle structural effects at the picometre scale can have a profound impact on macroscopic properties. This talk will explore the relationship between structure and properties in several functional perovskite materials being developed as photoabsorbers[1-4], ion conductors[5-6], colossal-magnetoresistors (CMR)[7-8] and relaxor ferroelectrics. Using specially developed electron diffraction and microscopy techniques, we will examine structure at the atomic scale, focusing on subtle departures from periodicity that can give a material its distinctive properties and influence its potential for use in functional devices. This includes the impact of local atomic-scale defects on perovskite photoabsorbers and the role of anharmonic structural modulations in Li-ion conductors, colossal magnetoresistors and relaxor ferroelectrics.

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Joanne Etheridge is an Australian Research Council Laureate Fellow in the School of Physics and Astronomy at Monash University. She obtained a degree and PhD in physics from the University of Melbourne and RMIT University, respectively, before appointments at the University of Cambridge in the Department of Materials Science and Metallurgy and Newnham College, including a Rosalind Franklin Research Fellowship and a Royal Society University Research Fellowship. She returned to Melbourne to join Monash University where she established the Monash Centre for Electron Microscopy. She conducts research in the theory and development of new electron scattering methods for determining the atomic and electronic structure of condensed matter. She applies these methods to understand structure-property relationships in functional materials, including materials for controlling light, energy generation and storage. She is a Fellow of the Australian Academy of Science.

Prof. Su-Huai Wei
Eastern Institute of Technology, China

Day 2: 14:00-14:35, Plenary Talk

Title: First Principles Design of Functional Materials for Energy and Optoelectronic Device Applications

Abstract: Materials design using first-principles techniques is one of the ultimate goals in computational materials science. Recent advances in first-principles electronic structure theory and computing power have enabled us to perform knowledge-based computational design of materials with unique properties that are tuned to specific energy and optoelectronic applications. This approach has now become a vital tool in accelerating scientific discovery of energy and optoelectronic materials. In this talk, selective topics from our recent studies will be discussed to illustrate how computational methods can be used to understand and design functional materials, including solar cell materials; thermoelectric materials; and transparent conducting materials.



Su-Huai Wei is currently a Chair Professor and Dean of School of Physics at the Eastern Institute of Technology (EIT), Ningbo, China. He received his Ph.D. from the College of William and Mary in USA in 1985. After that, he joined the National Renewable Energy Laboratory (NREL) and was a Laboratory Fellow and Manager of the Theoretical Materials Science Group before he joined the Beijing Computational Science Research Center (CSRC) as Head of the Materials and Energy Division in 2015. He moved to EIT in 2024. His research is focused on developing electronic structure theory of semiconductors for optoelectronic and energy related applications. He is a Fellow of both the American Physical Society and the Materials Research Society.

Prof. Debra Bernhardt
The University of Queensland, Australia

Day 2: 14:35-15:10, Plenary Talk

Title: Improving Materials and Devices through Atom- Level Understanding

Abstract: Development of new materials and devices for energy storage can be a costly and iterative process. However, if a better understand of what features and processes lead to better performance, a more cost effective and efficient approach to new energy conversion and storage can be achieved. Theoretical and computational methods provide an avenue to obtain atomic level understanding of processes and materials. Information on the structure of the materials and how that affects performance, the chemical reactions that occur at different catalytic surfaces, transport of ions through electrolytes and membranes, formation of solid-electrolyte interfaces, and double layers near electrodes can be gained. Our group is interested in developing new approaches to do these analyses, and in investigating problems that cannot be solved through laboratory experiments alone. In this talk I will discuss some of the systems that my group has recently considered.[1-5]. These include studies on the dynamic nature of the electric double layer and the effects of reactions that occur at the electrode.[1] I will also discuss approaches to calculate diffusion and conductivity of ions in an electrolyte,[2-3] and how these can be applied in complicated structures.[3-5]

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Short Biography: Debra Bernhardt is a Fellow of the Australian Academy of Science. She is known for advancing nonequilibrium statistical mechanics and thermodynamics and her research has been recognized through award of an ARC Australian Laureate Fellowship. She examines far-from-equilibrium and confined fluids using theoretical and computational approaches, with applications to a broad range of topics, especially next generation energy storage and conversion.

Room 1: Catalyst 5

Prof. Yijiao Jiang
Macquarie University, Australia

Day 2: 15:30-15:50, Keynote Talk

Title: Metal-Organic Frameworks for Sustainable Hydrogen Peroxide Production

Abstract: Hydrogen peroxide (H_2O_2) is a key green oxidant, yet conventional anthraquinone production remains energy-intensive and fossil-dependent. Metal–organic frameworks (MOFs) offer a tunable platform for sustainable, decentralized H_2O_2 generation. This work presents two complementary MOF-based strategies for photocatalytic and electrochemical H_2O_2 synthesis. First, a PET-derived mixed-linker UiO-66 photocatalyst is developed using terephthalate recovered from waste PET and amino-functionalized linkers. Controlled linker ratios modulate band structure, defect density, and charge-transfer pathways, enabling efficient visible-light-driven H_2O_2 production in pure water. Mechanistic analysis reveals synergistic enhancement of the $2e^-$ oxygen reduction and water oxidation pathways. Second, a glassy MOF platform is introduced for electrochemical H_2O_2 electrosynthesis, where MOF amorphization generates conductive, defect-rich catalytic films with high $2e^-$ ORR selectivity and operational stability. Together, these approaches demonstrate how defect engineering and structural disorder in MOFs can unlock scalable, green H_2O_2 production using sunlight or electricity.



Yijiao Jiang is a Professor in the School of Engineering at Macquarie University. She received her PhD from University of Stuttgart and worked as postdoc at ETH Zürich. She is the Co-Director of the Macquarie Transforming Energy Markets Research Centre. Her research focuses on the development of advanced technologies to convert carbon emissions, plastic and organic waste into sustainable fuels and valuable materials. She was awarded ARC DECRA, Future Fellowship and the Highly Commended Vice-Chancellor's Jim Piper Award for Excellence in Research Leadership. She also serves as an Associate Editor of Energy & Fuels and Carbon Capture Science and Technology.

Prof. Zongyou Yin
Australian National University, Australia

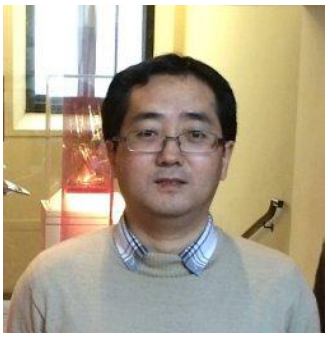
Day 2: 15:50-16:10, Keynote Talk

Title: Microenvironment Roles in Nano-to-Atomic Catalysis

Abstract: Heterogeneous catalytic systems based on nanomaterials have advanced energy conversion technology development. However, performance enhancement and cost-effectiveness still meet challenges, limiting their application potential. To address these challenges, the potential solutions are to introduce the local microenvironments - such as mechanical strain, electric fields, and internal Stocky barriers, etc.,- to tailor the catalyst surface activities, which have gained rising attention in micro-structured catalysis in energy and environmental fields. This talk will present our recent developments in the nanoscale solid-material based catalysts for photoreforming, water splitting and CO2 reduction etc. Our continuous research efforts have led to significant advancements in the design of integrated nanomaterials, incorporating both active catalytic sites and relevant microenvironment perturbations. In our design, we considered interior strain within solid phase, lattice-mismatch-induced interfacial strain, plasmonic resonance-induced electric fields, heterointerface induced interior barrier, and the remained surfactants post catalyst growth and their sole and combined effects on the catalysis. Our catalysts cover 2D materials, core/yolk-shell, Janus structures, and single atoms. These studies highlight the tunability of catalyst surface activity through materials integration, further enhanced by manipulating single-to-multiple local reaction environments. Nano-atomic integration with microenvironment engineering offers versatile strategies for tailoring performance in nano-energy advancements while mitigating environmental contamination.

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Dr. Zongyou Yin obtained his B.S. and M.S. degrees at Jilin University in China, and completed his Ph.D. at Nanyang Technological University (NTU) in Singapore. Then, he started his postdoc careers at NTU/Singapore, IMRE/Singapore, followed by MIT and then Harvard University. Dr Yin started his own Research Group at Australian National Univesrity (ANU) from 2017. His group's research is interdisciplinary, encompassing AI-driven materials innovations, nano-to-atomic materials science, fundamental relationship among materials-structures-devices, and synergistic integration of multi-functions towards systems for renewable energy and wearables applications.

Prof. Han Young Woo
Korea University, South Korea

Day 2: 16:10-16:30, Keynote Talk

Title: Organic Photocatalysts and Photoelectrochemical Cells for Green Hydrogen Generation

Abstract: Hydrogen (H_2) is widely recognized as a sustainable energy vector because of its high gravimetric energy density, facile transport, and carbon-free utilization. Among various green hydrogen production strategies, photocatalytic systems are particularly attractive owing to their conceptual simplicity and potential low cost, yet their practical application remains limited by insufficient efficiency. Thus, the development of advanced photocatalytic materials is crucial for enhancing hydrogen evolution activity and reducing overall system costs. Alongside the rapid growth of solar energy technologies, photoelectrochemical (PEC) cells have also attracted significant attention for direct solar-to-fuel conversion. In this regard, organic semiconductors have emerged as promising photoelectrode materials due to their strong light absorption and molecular tunability. However, their operation in aqueous PEC environments is still challenged by inefficient interfacial charge transfer and limited film stability. In this presentation, we introduce a new class of photoactive materials designed to overcome these limitations. Their optical properties and hydrogen evolution performance in both photocatalytic and PEC systems will be discussed. We will also highlight how molecular design controls material functionality and device behavior, providing design principles for efficient solar-driven hydrogen production.

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Han Young Woo received his Ph.D. in Chemistry from the Korea Advanced Institute of Science and Technology (KAIST) in the Republic of Korea in 1999. After completing postdoctoral training at the University of California, Santa Barbara (UCSB) in the USA, he joined Pusan National University as an assistant professor. In 2015, he moved to Korea University, where he is currently a professor in the Department of Chemistry. His research focuses on the design and synthesis of conjugated polymers and conjugated polyelectrolytes to develop organic and polymer semiconductor materials with tailored optical and electrical properties.

Dr. Tim Connell
Deakin University, Australia

Day 2: 16:30-16:45, Invited Talk

Title: Surpassing Photon Energy Limits for Light-Driven Chemical Synthesis

Abstract: Using visible light to make molecules promises more sustainable practices in chemical synthesis, where photons supply the required energy instead of high temperature or pressure. Photoredox catalysis, combining light-driven and redox chemistry, offers unique reactivity and selectivity to conventional methods and transition metal catalysis. Photocatalysts absorb light to form excited states that act as single-electron oxidants or reductants and provide mild access to open-shell radical intermediates. Over the last 15 years photoredox catalysis has become a versatile tool for synthetic chemists, enabling innovative method development in late-stage functionalisation, C-H activation and skeletal editing. The energy of an absorbed photon typically sets intrinsic limits on the resulting chemical reactivity. Further limitations are imparted by the photocatalyst, which must expend some energy to convert light into chemical potential. These unavoidable energy losses underpin a reliance on costly precious metal catalysts that maximise the accessible redox potential but inefficiently utilize high energy photons. Multi-photon excitation is an emerging strategy that modestly overcomes these energy limits by combining multiple photons for a single reactive step, but at the expense of greatly diminished efficiency. This presentation discusses recent work that represents a radically different approach to synthetic photochemistry. By decoupling the redox requirements from the light-harvesting catalyst, we instead exploit overlooked sacrificial additives and convert the free energy of their chemical bonds into redox potential. This approach makes it possible to surpass photon limits without sacrificing reactivity, and increases photochemical efficiency.



Tim completed his PhD at the University of Melbourne in 2015 and, following postdoctoral appointments at CSIRO and RMIT University, awarded a 2019 Fulbright Future Scholarship at Carnegie Mellon University. Tim started his independent career as an ARC DECRA Fellow at Deakin University in 2021, where he is now a Senior Lecturer. His research program focuses on the interaction of light and matter, and particularly the photocatalytic conversion of light into chemical energy. Recent recognition of his research includes the 2022 Royal Australian Chemical Institute's Organometallic Prize and the 2023 Young Scientist Prize from the Asian and Oceanian Photochemistry Association.

Dr. Martina Lessio
UNSW, Australia

Day 2: 16:45-17:00, Invited Talk

Title: Mechanistic insights into catalytic chemical recycling of polyethylene waste for a circular plastics economy

Abstract: Developing efficient technologies for the conversion of polyolefin plastic waste into high-value products, including feedstocks for the production of new virgin-like plastics, is a critical milestone toward achieving plastic circularity. Advanced chemical recycling strategies that use catalysts to convert the polyolefin waste via pyrolysis or hydrogenolysis are a promising route. However, they typically lead to wide product distributions, including excessive methane formation, that hamper the efficiency of the process. Molecular-level insights into the conversion mechanism are needed to design better catalysts that lead to narrow product distributions centred around the most desirable products. My research group uses computational methods to gain such insights and aid the development of new catalysts for catalytic advanced recycling of polyolefins. In this contribution, I will focus on two recent systems we have been working on. First, I will present our work on ruthenium-catalysed hydrogenolysis of polyolefin plastic waste. In this work, we used periodic density functional theory (DFT) to determine the surface coverage of atomic hydrogen under operating conditions for different facets of ruthenium as well as the plastic polymer cleavage mechanism. Furthermore, we have used classical molecular dynamics (MD) to study how the polymer interacts with the catalyst surface in the presence of hydrogen and how the hydrogen can diffuse through the polymer melt and reach the surface to participate in the cleavage mechanism. In the second part of my contribution, I will focus on our recent efforts to study the interaction of polyolefins with porous metal–organic framework-based catalysts for pyrolytic recycling, with particular emphasis on UiO-66, which has been shown to improve product distributions. To this end, we use classical MD simulations to investigate how variations in chain length and branching influence preferential interactions with different pores, as well as the diffusion of polymers and their resulting fragments within the MOF.

Keywords: plastic recycling, catalysis, mechanisms, Density Functional Theory, Molecular Dynamics



Martina Lessio is a Scientia Senior Lecturer in the School of Chemistry at UNSW Sydney. Originally from Torino, Italy, she completed her chemistry training in Italy before earning a PhD in Chemistry from Princeton University in 2017 under Professor Emily Carter. She then held a Columbia Science Fellowship at Columbia University, where she combined teaching and research in functional materials. After moving to Australia, Martina joined the University of Sydney as a Fellow before commencing at UNSW in 2020. Her research uses computational chemistry to design molecules and materials for sustainability applications. Her work has been recognised through a RACI Rita Cornforth Lectureship and an ARC DECRA Fellowship.

Room 2: Optoelectronic 1

Prof. Heike Ebendorff-Heidepriem
Adelaide University, Australia

Day 2: 15:30-15:50, Keynote Talk

Title: Optical glasses and fibers: a powerful platform for new sustainable technologies

Abstract: Optical glasses offer a huge versatility in optical properties through tailoring of glass composition and doping with luminescent species (lanthanides, crystal particles). Their ability to be processed and shaped at elevated temperatures opens up unprecedented control of optical fiber cross-sectional structures and new avenues to incorporate crystal particles or to suppress their formation in glass. These features make optical glasses and fibers a powerful platform to develop new technologies for a sustainable and energy-efficient future as illustrated by these examples:

- extrusion-based glass shaping techniques for fabricating optical fibre preforms with new structures [1,2,3]
- optical fibers for high-temperature sensing in harsh industrial environments [4]
- optical fibers doped with luminescent diamond particles for quantum-based magnetic field sensing [5,6,7]
- eco-friendly colored glass through unprecedented control of the size and concentration of gold nanocrystals in glass [8]
- robust long-lasting glass-based tissue-mimicking phantoms with tailored absorption, luminescence and scattering for calibration of imaging systems [9]
- ZBLAN fluoride glass fibers drawn in microgravity for next-generation fibre optics cables with reduced energy consumption for data communication [10]
- Future: lanthanide ion doped glass for downconversion to enhance photovoltaic solar energy conversion efficiency [11,12]

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Heike Ebendorff-Heidepriem is Professor in Photonic Materials and Optical Fibres, ARC Industry Laureate Fellow and Deputy Director of the Institute for Photonics, Advanced Sensing and Quantum Technologies (IPAS-QT) at Adelaide University. She received the Ph.D. degree in 1994 at the University of Jena, Germany, where she continued until 2000. In 2021, she moved to the Optoelectronics Research Centre in Southampton, UK; and since 2005, she is with the University of Adelaide, which is since 2026 Adelaide University, Australia. Her research focuses on the development of novel optical glasses and specialty optical fibres for science and industry applications.

Prof. Dzung Dao
Griffith University, Australia

Day 2: 15:50-16:10, Keynote Talk

Title: Robust and Self-Powered Sensing Based on Semiconductor Heterojunctions

Abstract: Semiconductor heterojunctions, formed by integrating two dissimilar semiconductor materials, have emerged as a powerful platform for next-generation sensing technologies. By engineering the band alignment and carrier transport across the interface, heterojunctions such as SiC/Si, GeSe/Si, and AlGaN/GaN exhibit unique electronic, optoelectronic, and piezo-optoelectronic properties that are difficult to achieve using single-material semiconductors. These heterostructures provide enhanced carrier separation, high sensitivity [1,2], broad spectral response, improved energy conversion efficiency [3], and the potential for self-powered operation [4,5], making them highly attractive for advanced sensing applications. This keynote will present recent advances from our research group on novel sensing mechanisms based on semiconductor heterojunctions, spanning wide-bandgap semiconductors, two-dimensional materials, and hybrid semiconductor systems. Particular emphasis will be placed on how heterojunction engineering enables efficient charge generation, separation, and transport, resulting in superior performance for physical sensing, including ultraviolet photodetection, strain sensing, pressure sensing, and temperature sensing. The underlying sensing mechanisms, together with the coupling between optical, electrical, thermal, and mechanical effects, provide new opportunities for designing highly sensitive and energy-efficient sensing devices. These fundamental discoveries have enabled the development of robust MEMS (Micro-Electromechanical Systems) sensors with exceptional sensitivity, self-powered operation, and reliability under harsh operating conditions. By integrating these high-performance MEMS sensors with low power, long-range Internet of Things (IoT) communication technologies, we have demonstrated scalable wireless sensor networks for applications such as flood monitoring, highway infrastructure safety, precision agriculture, and smart environmental monitoring. These advances position semiconductor heterojunctions as a key enabling technology for the next generation of robust, self-powered, and sustainable sensing systems.

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Prof. Dzung Viet Dao received his Ph.D. in MEMS Technology from Ritsumeikan University, Japan, in 2003. He joined Griffith University in 2011 and is currently a Professor at the Queensland Quantum and Advanced Technologies Research Institute. His research focuses on ultrasensitive sensing effects in semiconductor 2D materials, wide-bandgap semiconductors, heterojunctions, MEMS self-powered sensing, and sensors for harsh environments. Prof. Dao has published over 450 peer-reviewed publications, authored 9 books & book chapters, filed 18 patents, secured over $13M research funding, and supervised/co-supervised 31 Ph.D. students to completion.

Prof. Lan Fu
The University of Queensland, St Lucia, QLD 4072, Australia

Day 2: 16:10-16:30, Keynote Talk

Title: III-V semiconductor nanowire arrays for optoelectronic device applications

Abstract: III-V compound semiconductor nanowires have drawn much attention as nanoscale building blocks for optoelectronic/photonic integration owing to their nanoscale size, excellent optical and electrical properties, and strain relaxation ability for lattice-mismatched systems enabling epitaxial growth of a wide range of high-quality materials and structures. In particular, highly uniform, ordered, vertical nanowire arrays exhibit strong geometry related light matter interaction properties, offering unique flexibility for the design of a variety of geometry-tunable high performance and multifunctional light emission and detection devices, as well as light activated gas sensors. In this work, I will present our recent work on design, growth and fabrication of III-V nanowire array-based lasers, LEDs, photodetectors and gas sensors for next-generation integrated photonic/optoelectronic systems and IoTs.

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Professor Lan Fu is Head of the Department of Electronic Materials Engineering at the Research School of Physics, Australian National University. Her research focuses on the design, fabrication, and integration of optoelectronic devices, including LEDs, lasers, photodetectors and solar cells, as well as chemical sensors based on low-dimensional III-V compound semiconductor nanostructures, such as quantum wells, self-assembled quantum dots, and nanowires. She is a Fellow of Optica and a past recipient of the Australian Research Council Postdoctoral, ARF/QEII, and Future Fellowships.

Dr. Miaoqiang Lyu
The University of Queensland, St Lucia, QLD 4072, Australia

Day 2: 16:30-16:50, Keynote Talk

Title: Rational Design of Low-toxicity Metal Halide Perovskites for Optoelectronic Applications

Abstract: Metal halide perovskites have attracted tremendous research attention in the past decades due to their rapid progress and breakthroughs as one of the most promising photovoltaic technologies. This family of materials have superior properties, such as solution-processability, easy fabrication with high crystallinity, highly tunable optical bandgaps, high defect tolerance, high light-absorption coefficient and large carrier lifetime, which enable them as very promising candidate for the next-generation high-performance optoelectronic applications. However, serious concerns on the use of toxic lead as well as the instability of these perovskites in indoor conditions have inspired increasing efforts towards developing non-toxic and stable metal halide perovskite and perovskite-inspired alternative materials. Herein, we focus on the rational design of low-toxicity metal halide perovskites and explore their potential applications, with a particular focus on indoor light energy conversion and artificial synapses. Owing to the outstanding light absorption capability of these materials under weak light conditions, we demonstrate that low-toxicity perovskites can be ideal candidates for the next-generation indoor photovoltaics for powering off-the-grid Internet-of-Things electronics. Solution and vacuum evaporation methods were developed for high-quality thin-film processing, which in turn led to the enhance power conversion efficiencies in the indoor photovoltaic devices. In addition, the unique ionic and optoelectronic properties also enable them as promising semiconductors for the emerging artificial synapses and neuromorphic computing devices. Low-toxicity metal halide perovskites hold great promise for these emerging optoelectronic applications, and we demonstrate that additive engineering in the perovskite precursor can regulate the thin-film fabrication process as well as the resultant film properties, which is critical in achieving high-performance optoelectronic devices.

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Dr Miaoqiang Lyu is an ARC Future Fellow and Group Leader in the School of Chemical Engineering at The University of Queensland, Australia. His research focuses on the design and applications of advanced optoelectronic materials, particularly lead-free halide perovskite semiconductors for indoor photovoltaics, solar cells and phototransistors. His research also advances research of printed energy storage devices for applications in wearable and IoT electronics. Dr Lyu has published 94 peer-reviewed articles, accumulating over 11,600 citations and an h-index of 45.

Dr. Xinyu Shen

University of Oxford, UK

Day 2: 16:50-17:05, Invited Talk

Title: Rational Design of Phosphine Oxide for Efficient Perovskite Light-Emitting Diodes

Abstract: Metal halide perovskites have shown great potential for next-generation display technologies due to their high colour purity and photoluminescence quantum yields. Although generally considered defect-tolerant compared to conventional semiconductors, accumulating evidence indicates that defects still critically impact the performance and stability of perovskite light-emitting diodes (LEDs).1 Additionally, the influence of carrier injection and charge transport layers plays a vital role in determining device efficiency. In this work, we systematically investigate the multifunctional roles of phosphine oxide molecules in enhancing perovskite LED performance. Based on the principles of defect passivation, we introduce diphenylphosphinamide and phosphonic acid as additives to effectively passivate surface defects, regulate phase distribution, and promote efficient energy transfer in quasi-2D perovskite films. These treatments lead to significantly improved optoelectronic properties and device efficiencies.2,3 Very recently, we reported that the phosphine oxide can be utilized to regulate the growth and assembly of in-situ synthesized perovskite nanocrystals, enabling high performance LEDs.4 In parallel, we design tris(4-trifluoromethylphenyl)phosphine oxide to tailor the energy level alignment and improve hole mobility within the widely used poly(9-vinylcarbazole) (PVK) hole transport layer, achieving further performance enhancements, particularly in blue perovskite LEDs.5 Our results demonstrate that phosphine oxide can serve multi-functions: as effective passivation agents for perovskite films, and as modifiers for charge transport layers. This dual strategy provides a versatile platform for simultaneously optimizing both the emissive layer and carrier transport interfaces in perovskite LEDs. These findings offer valuable insights for advancing high-performance, stable perovskite-based optoelectronic devices.

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Dr. Xinyu Shen is an EPSRC IAA Postdoctoral Research Fellow at the University of Oxford. Her research focuses on nanoscale semiconductor optoelectronic materials and applications, with particular interests in metal-halide perovskite fabrication, optoelectronic properties, and their applications in light-emitting diodes. She received her PhD in Microelectronics and Solid-State Electronics from Jilin University in 2021 and has held research positions at Sungkyunkwan University and Pukyong National University. Her research has been published in leading journals in nanoscale optoelectronic materials and devices. Her current interests include the development and application of advanced materials.

Room 3: Low Energy Devices 3

Prof. Justin M. Chalker
Flinders University, Australia

Day 2: 15:30-15:50, Keynote Talk

Title: Sustainable Gold Extraction from Ore and Electronic Waste

Abstract: Gold plays an essential role in science, technology and society. It has served as a currency and medium for art for centuries, and it is widely used in modern catalysis, electronics, and aerospace. Unfortunately, gold mining is not sustainable, with land clearing and use of toxic substances such as mercury and cyanide harming the environment. More sustainable methods for gold extraction and recovery are needed. In this presentation, sustainable methods for gold extraction, recovery and refining will be presented.[1] The methods are integrated across the whole gold recovery process, including sourcing, pre-processing, leaching, recovery, refining and recycling. Novel and safer leaching chemistry is reported, along with a novel and recyclable polysulfide material that is exquisitely selective for binding gold in highly complex mixtures. Pilot studies on ore, electronic waste, and scientific waste will be presented. More generally, this project reflects our efforts to add value to the sulfur supply chain by providing useful, recyclable, and sustainable materials derived from surplus elemental sulfur.[2,3]

Keywords: e-waste, recycling, gold, sulfur, polymers

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Justin M. Chalker is currently an ARC Future Fellow and Matthew Flinders Professor of Chemistry at Flinders University. His research interests include the application of sulfur-based polymers to grand challenges in sustainability including chemically recyclable plastics, safer gold mining, and polymer alternatives to critical minerals. Justin has earned >$12M AUD in competitive funding for his scholarly activities and won several awards for his efforts in teaching and research. These include the SA Science Excellence Awards STEM Educator of the Year (2018) and the Prime Minister's Prize for New Innovators (2020), one of the top science prizes in Australia.

Prof. Stefan Maier
Monash University, Melbourne, Australia and Imperial College London, London UK

Day 2: 15:50-16:10, Keynote Talk

Title: Nanophotonics for energy conversion

Abstract: Metasurfaces — nanostructured surfaces of metallic or insulating materials with a pitch well below the wavelength region of interest — provide unprecedented control of harvesting and manipulating of electromagnetic waves. In my talk I will present a number of examples in the context of optical sensing and photochemistry. The strength of radiative coupling of an optical resonance, its radiative quality factor, allows an additional tuning knob for the sensitivity of the resonance upon binding of molecules, rather than the frequency of the resonance alone. Metasurfaces with quasi-bound states in the continuum resonances allow high control over both resonance frequency and radiative quality factor via the concept of gradient metasurfaces [1]. Judicious choice of radiative quality factor enables the exploitation of critical coupling, which influences the strength of light-matter interactions for example in a context of surface-enhanced infrared absorption (SEIRA) [2] or photocatalytic energy conversion [3]. In addition to designer metasurfaces, random particle arrays provide another avenue to achieve critical coupling [4].

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Biography: Stefan Maier FAA obtained his PhD in Applied Physics at Caltech. He is currently Professor in the School of Physics and Astronomy at Monash University, and Lee Lucas Chair in Experimental Physics at Imperial College London. At Monash, he served as Head of School from 2022 to 2026. His research interests are in plasmonics, nanophotonics, and energy conversion. He was elected into the Australian Academy of Science in 2026.

Dr. Shuhua Peng
UNSW, Australia

Day 2: 16:10-16:30, Keynote Talk

Title: Microstructure design for high-performance wearable pressure sensors

Abstract: Soft super-capacitive pressure sensors have attracted increasing attention for next-generation wearable electronics and robotic electronic skins due to their excellent mechanical flexibility, high sensitivity, fast response, and biocompatibility. These outstanding sensing capabilities are primarily enabled by soft ionic elastomers and the electrical double-layer (EDL) sensing mechanism. However, achieving high sensitivity while maintaining a broad linear sensing range remains a significant challenge, particularly for applications requiring accurate pressure quantification over a wide range. Rational microstructure design within the electrolyte and electrode layers provides an effective approach to enhance sensor performance, improve repeatability, and enable scalable fabrication. In this work, we present a novel microstructure engineering strategy to simultaneously enhance sensitivity, extend the linear sensing range, and improve the stability of super-capacitive pressure sensors.[1-4] By systematically tailoring the architectures of both the ionic electrolyte and electrode layers, the structure–property relationship governing the EDL-based sensing mechanism is investigated. The results demonstrate that optimized microstructures, together with controlled viscoelastic properties, significantly enhance ion redistribution, interfacial contact evolution, and mechanical deformation behaviour under pressure. In particular, height-graded microstructures enable highly sensitive and linear pressure responses across an extended sensing range while maintaining excellent stability and repeatability.
The developed sensors demonstrate excellent capability for real-time monitoring of human physiological and motion signals, including body movements, respiration patterns, and wrist pulse detection. Furthermore, their potential as robotic electronic skin (e-skin) is demonstrated through pressure mapping, object weight estimation, and intelligent object recognition. Combined with machine learning algorithms, the sensor achieves highly accurate object classification with 100% recognition accuracy. This work establishes fundamental structure–property–performance relationships for microstructured super-capacitive sensors and provides new design guidelines for developing next-generation wearable sensing systems, intelligent robotic interfaces, and human–machine interaction technologies.

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Dr Shuhua Peng is a Senior Lecturer and ARC Future Fellow in the School of Mechanical and Manufacturing Engineering at the University of New South Wales (UNSW). He previously held an ARC Discovery Early Career Researcher Award (DECRA, 2019–2022). His research focuses on advanced polymer composites and functional nanomaterials, with applications in wearable sensors, flexible electronics, micro/nanofabrication, and energy harvesting and storage. His work integrates materials science, manufacturing, and device engineering to develop next-generation soft electronic systems for healthcare, robotics, and sustainable technologies.

Dr. Tao Wan
University of New South Wales, Australia

Day 2: 16:30-16:45, Invited Talk

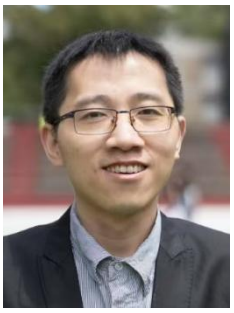
Title: Atmospheric Moisture Energy Harvesting for Sustainable Energy Supply

Abstract: Harvesting moisture energy into usable electricity has recently emerged as a green and sustainable approach to powering small electronic devices. However, this technology still suffers from low energy conversion efficiency, limited long-term stability, and a strong dependence on high-humidity environments, which constrain its practical deployment. To address these challenges, functional materials with tailored compositions and microstructures have been developed to enhance interactions with ambient moisture and improve power generation. In parallel, the transport of water molecules and ions has been regulated through the engineering of device architectures and interfacial properties. As a result, moist-electric generators with enhanced power output and excellent environmental durability have been realised, enabling the reliable operation of diverse flexible and wearable electronic systems.

Keywords: moisture energy harvesting, ion transport, structural engineering

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Dr. Tao Wan is a lecturer at School of Materials Science & Engineering, The University of New South Wales. His research interests encompass the design and development of advanced functional materials and devices for sustainable energy harvesting, energy storage, and intelligent sensing technologies, with a particular emphasis on optimizing material structures, understanding interfacial processes, and translating research outcomes into practical technologies.

Ziheng Feng
UNSW, Australia

Day 2: 16:45-16:57, Oral Talk

Title: From Atmospheric Water Harvesting to Energy Conversion

Abstract: Beyond being an indispensable resource for life, atmospheric water has recently emerged as a promising, eco-friendly energy source through hydrovoltaic technology.[1-5] Of significant interest, the cyclic sorption and desorption of water molecules induce dynamic gas/liquid–solid interactions, offering tremendous potential for continuous electricity harvesting. Herein, we developed a high-performance moisture-enabled generator (MEG) based on a synergistic dual-layered architecture, comprising an ionic hydrogel and a graphene oxide (GO) membrane, to directly convert chemical energy from ambient moisture into electric power.[2] In this design, the water-enriched hydrogel serving as an active water-capturing layer ensures a continuous water supply, while the nanochannels within the GO layer effectively regulate ion diffusion, suppressing local charge accumulation for stable output. Consequently, the optimized MEG delivers a maximum power density of 71.7 μW cm^{-2} and a sustained voltage of 0.6 V for over 1400 h under ambient conditions without degradation. Remarkably, owing to the robust internal dynamic water equilibrium, the device operates efficiently across a wide temperature range from -20 °C to 50 °C, and achieves an ultrahigh, stable voltage of 1.2 V even in an extremely dry environment (0% RH). Finally, we demonstrate the practical viability of this MEG in continuously powering wearable electronics and distributed IoT sensors. This work provides crucial insights and structural guidelines for designing long-life, all-climate applicable hydrovoltaic energy harvesters.

Keywords: Hydrovoltaic technology, Atmospheric water harvesting, Hydrogel, Energy conversion

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Room 4: Battery 4

Prof. Xiwang Zhang
The University of Queensland, Australia

Day 2: 15:30-15:50, Keynote Talk

Title: From Separation to Recognition through Nanoconfinement: Precision Nanochannel Membranes

Abstract: Selective separation of ions and molecules with similar size, charge, and physicochemical properties remains a grand challenge in membrane science. Membranes inherently create confined environments through nanopores, sub-nanometre channels, interlayer galleries, and the intrinsic free volume of dense polymers. Within these confined spaces, the physicochemical properties of solvents and solutes—including hydration, hydrogen bonding, dielectric response, diffusion, and molecular interactions—can differ substantially from those in bulk environments. These confinement-induced effects provide new opportunities for molecular recognition and precision transport. This talk will first discuss nanoconfinement as a defining feature of membrane systems and examine how confinement reshapes molecular behaviour. And then highlight how advanced membrane materials provide well-defined platforms for understanding confinement-induced molecular interactions. Particular emphasis will be placed on the evolution from static interactions, such as adsorption and binding, toward dynamic interactions involving hydration, desolvation, diffusion, and transient molecular recognition within nanochannels.

Prof. Liping Wang
University of Electronic Science and Technology of China, China

Day 2: 15:50-16:10, Keynote Talk

Title: Pyrites as sustainable high energy density lithium metal battery cathodes

Abstract: Conversion-type transition metal-based materials are considered promising cathodes for lithium metal batteries due to their low cost, abundant availability, and high theoretical energy density[1]. However, they suffer from a rapid capacity decay caused by transformation into two inhomogeneous phases during discharge. Here, we use a nature mineral pyrite FeS_2 with ultra low-cost as a typical cathode. We develop a series of strategies to unlock its longevity, 1) fabricating a 3D ionic-electronic network via fabricating new chelating-type binders and compatible electrolytes (Figure 1) [2-3]; 2) introducing a pulse discharge current to induce homogeneous phase nucleation-growth for discharge products [4-5]. Consequently, we can achieve micro-sized FeS_2 an ultra-long cycling life to be 10000 cycles.

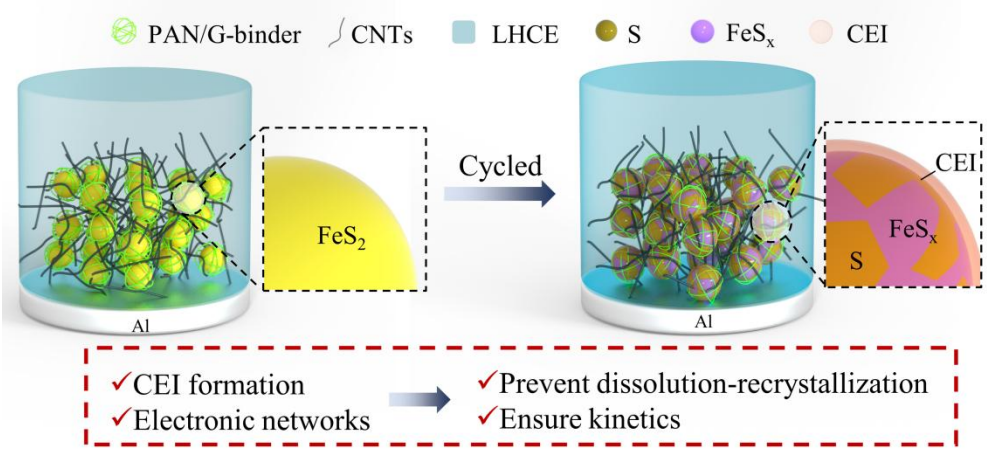


Figure 1. 3D ionic-electronic network for long cycling life FeS_2.

Keywords: Pyrite, conversion-type cathode, lithium metal battery

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Liping Wang is a professor at the University of Electronic Science and Technology of China. She received her dual PhD in 2011 from the Institute of Physics, Chinese Academy of Sciences (China) and Université de Picardie Jules Verne (France). She was a postdoctoral fellow at the Max Planck Institute (Germany) and a research associate at Brookhaven National Lab (USA). Her research focuses on Li-based high-energy rechargeable batteries, covering electrode materials and wide-temperature electrolytes. She has published over 150 papers in journals such as *Joule*, *JACS*, and *Advanced Materials*, with >9,000 citations. She holds 20 granted patents and was awarded the National Outstanding Youth Science Fund of China.

Prof. Luke C. Henderson
Deakin University, Australia

Day 2: 16:10-16:30, Keynote Talk

Title: Piezoelectric effects of neat ionic liquids and as part of bicontinuous solid polymer electrolytes

Abstract: Recent advances in multifunctional materials have demonstrated the potential of solvate ionic liquids (SILs) to serve simultaneously as mechanical load-bearing and energy storage components. We systematically investigated how compressive and bending forces applied to carbon fibre-based structural supercapacitors generate measurable electrical outputs. A strong linear relationship was found between applied mechanical force and open circuit potential (OCP) response ($R^2 = 0.973$), demonstrating that these materials reliably convert mechanical stress into usable electrical energy. Notably, the OCP was observed to plateau at approximately 150 mV at forces exceeding 200 N, suggesting a pressure threshold beyond which additional loading no longer increases electrical output, a behaviour linked to saturation effects within the polymer matrix. These findings lay important groundwork for structural components capable of passively harvesting energy from everyday mechanical loading, such as vibration or applied pressure, without the need for separate dedicated energy harvesting devices.[1] Building on this foundation, further studies focused on making these materials practical and scalable through 3D printing. Using UV-assisted masked stereolithography, porous solid polymer electrolytes were printed directly onto woven carbon fibre substrates, streamlining what has traditionally been a labour-intensive fabrication process. By adjusting the ratio of SIL within the resin formulation, the team identified compositions that balanced electrical performance with structural integrity. To rigorously evaluate performance, three distinct loading protocols were applied, reaching maximum compressive forces of 80 N, 120 N, and 300 N, respectively, with each increment repeated three times to confirm reproducibility. The resulting devices demonstrated stable electrochemical performance, representing a meaningful step toward manufacturable, next-generation structural energy storage composites with real-world applications in aerospace, automotive, and civil infrastructure sectors.[2]

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Luke is a Professor of Materials Chemistry at the Institute for Frontier Materials, Deakin University. His primary area of research is on the surface modification of materials, most commonly carbon fibres, to install a range of functionalities into the fibres and their composites. He is currently an ARC Mid-Career Industry Fellow.

Assoc. Prof. Bin Luo
The University of Queensland, Australia

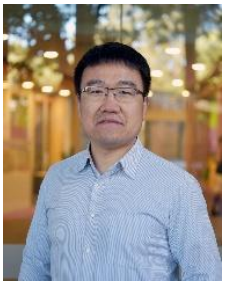
Day 2: 16:30-16:50, Keynote Talk

Title: Interfacial Engineering for Metal-Based Rechargeable Batteries

Abstract: The surging global demand for sustainable energy and the depletion of fossil-fuel reserves underscore the urgent need for advanced energy storage systems. Metal-based rechargeable batteries offer compelling advantages in energy density, cost, and sustainability. However, the practical implementation of these systems is often hindered by instability in the metal plating/stripping process, leading to dendrite growth, parasitic reactions, corrosion, and loss of active material. These interfacial challenges are universal across monovalent and multivalent metal systems, and overcoming them is critical for enabling long-life, high-performance batteries. This presentation will discuss recent progress in interfacial engineering and functional material design to control metal deposition behaviour. For sodium metal, we demonstrate that carbon nanofiber films with dynamically coordinated tin single atoms can not only enhance Na-ion adsorption at coordinated sites but also activate remote carbon atoms, yielding uniform sodium deposition, complete stripping, and stable cycling for 1200 h at 100 mA cm^{-2}. For zinc metal, we present a biomimetic antifreeze protein-based localized gel electrolyte that tailors Zn^{2+} solvation and promotes (002) Zn-faceted growth, suppressing dendrites, hydrogen evolution, and corrosion. This approach enables symmetric Zn cells to operate for 610 h at 10 mA cm^{-2} and delivers excellent stability in practical pouch cells. Additionally, this talk will provide a brief glimpse into our research endeavours, including collaborative efforts with industry partners, in the realm of Zn and Fe based redox flow battery technologies.

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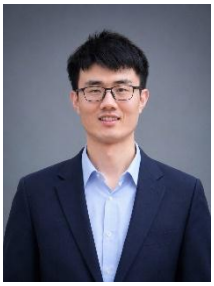
Biography: A/Prof Bin Luo is an ARC Mid-Career Industry Fellow & Group Leader in Australian Institute for Bioengineering and Nanotechnology (AIBN) & School of Chemical Engineering at the University of Queensland (UQ). He received his doctoral degree in Physical Chemistry from National Centre for Nanoscience and Technology of China, University of Chinese Academy of Sciences in July 2013. Dr Luo's research focuses on the design of new functional nanomaterials for energy storage applications.

Dr. Shilin Zhang
Adelaide University, Australia

Day 2: 16:50-17:05, Invited Talk

Title: Interfacial Engineering for Aqueous Zn Battery

Abstract: To promote the practical application of aqueous zinc batteries, which offer exceptional safety and high volumetric capacity despite having lower specific energies than nonaqueous systems, various strategies have been employed to eliminate associated challenges, such as severe parasitic reactions, dendrite growth, and unstable solid electrolyte interphase layers. In this talk, I will discuss our recent findings to address the issue of interface and poor reversibility at the electrode electrolyte interface. I will introduce our latest achievements in understanding the impact of anion polymer affinity engineering on the kinetics of high speed and stable zinc deposition. By clarifying the mechanism of reversing the Hofmeister response in hydrated soft materials, we achieved the goal of thermodynamic, kinetic, and stable regulation of charge carrier transport behavior at the electrode electrolyte interface.



Biography：Shilin Zhang is currently a Senior Research Fellow at the Adelaide University, Adelaide, Australia. He received his Ph.D. from the University of Wollongong in 2020. His research focuses on functional materials and interfaces for rechargeable batteries.

Room 5: 2D Materials 2

Prof. Sumeet Walia
RMIT University, Australia

Day 2: 15:30-15:50, Keynote Talk

Title: Ultra-thin materials for next-generation electronics and optoelectronicstechnologies

Abstract: Atomically thin materials possess unique intrinsic properties and offer exceptional tunability across electronic, optical and mechanical domains. In this talk, I will present our approach to harnessing these properties, guided by application needs and co-designed with industry to accelerate translation into end-user technologies. We synthesise a diverse range of atomically thin metal oxides, mono- and dichalcogenides, and elemental 2D materials using solid, liquid and vapour phase techniques tailored to targeted applications. Through defect engineering, we have demonstrated neuromorphic vision and processing sensors, while hybridising dissimilar materials has enabled enhanced electronic and optical performance. Ultra-thin layers have further been leveraged to develop one of the world's thinnest photodetectors, capable of sensing across the UV–infrared spectrum. More recently, we have explored defect formation and passivation strategies in monolayer transition metal dichalcogenides for optoelectronic and health sensing applications. Through a cross-disciplinary approach, we deploy the multifunctionality of these material systems to address technological challenges faced by industry partners across multiple sectors. Translation of these discoveries into real-world sensing solutions is enabled through IC-SensE, the ARC Industrial Transformation Hub for Intelligent Contaminant-Sensing in Complex Environments where we integrate advanced materials, devices and system-level engineering to deliver deployable sensor platforms for environmental, industrial and health monitoring applications.



Biography: Sumeet is a Professor in engineering at RMIT University. He is the Director of the Centre for Opto-electronic materials and sensors. He is also the Director of the ARC Industrial Transformation Research Hub for intelligent contaminant-sensing in complex environments (IC-SensE). He has co-authored over 180 peer reviewed publications including authoritative reviews in prestigious journals, a named inventor on fourteen patents and editor of two books for the CRC Press. His scientific and leadership contributions have been recognised through several national and international awards including the Eureka Prize for Science leadership.

Prof. Yulin Zhong
Griffith University, Australia

Day 2: 15:50-16:10, Keynote Talk

Title: Green Electrochemical Production and Engineering of Nanomaterials

Abstract: Electrochemical engineering is a powerful technique that has been applied on industrial scale to cost-effectively produce valuable chemicals and materials that are otherwise difficult to produce via traditional chemical synthesis (i.e. utilising heat or catalysts). We have employed a combination of highly robust boron-doped diamond (BDD) with a wide electrochemical potential window and commercially available fused deposition modelling (FDM) 3D printing to fabricate a scalable packed-bed electrochemical reactor (PBER) for graphene oxide production. Furthermore, the niche feature of 2D carbides and nitrides of transition metals (MXenes) was capitalised in our packed-bed electrochemical reactor to produce MXenes at an unprecedented reaction rate and yield with minimal chemical waste. A simple NH4F solution was employed as the green electrolyte, which could be used repeatedly without any loss in its efficacy. In addition to the exfoliation of 2D materials, we have expanded the capability of our PBER towards the electrochemical synthesis of functional energy storage materials.

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Yu Lin Zhong completed his B.Appl.Sc (Hon) and PhD in Chemistry at NUS and did his post-doctoral training at Princeton (2009) and MIT (2011). Thereafter, he worked as a Research Scientist at IBN, A*STAR Singapore, (2012) and an ARC DECRA Fellow at Monash University (2013). He joined Griffith University in 2016 and is currently a Professor and Academic Lead of Materials and Analytical Chemistry at the School of Environment and Science. His research group interests include electrochemical production of 2D nanomaterials and 3D printing of energy storage and wearable devices.

Prof. Daniel S.P. Lau
The Hong Kong Polytechnic University, Hong Kong S.A.R, China

Day 2: 16:10-16:30, Keynote Talk

Title: Switchable ferroelectricity in van der Waals magnets

Abstract: Ferroelectricity and metallicity are generally considered mutually exclusive, because mobile charge carriers in metals tend to screen the long-range electrostatic forces required for stable switchable polarization. It therefore remains an important open question in condensed matter physics whether a robust and reversible polar degree of freedom can exist in a metallic magnetic system and couple to its spin order. Here, we experimentally realize an intrinsic ferroelectric ferromagnetic metal in self-intercalated, two-dimensional non-stoichiometric chromium tellurides. In contrast to conventional multiferroics, the out-of-plane polarization originates from symmetry-breaking displacements of chromium atoms, stabilized by a non-stoichiometric lattice formed through multivalent-ion intercalation. Using aberration-corrected scanning transmission electron microscopy, we directly visualize polarization reversal at the atomic scale in real time, revealing that switching proceeds through short-range motion of intercalated atoms between neighboring coordination sites. This reversible polarity strongly influences electronic transport in the metallic state, giving rise to a ferroelectric memristive response. We further show that the coupled electric and magnetic dipole orders interact, as probed by optical second-harmonic generation under an applied magnetic field. These results identify structural polarity as an active and controllable degree of freedom for manipulating both spin and electronic behavior. More broadly, our work establishes self-intercalation as a general strategy for creating tunable structural polarity in metallic van der Waals magnets, opening a route toward reversible symmetry control of magnetism and electronic functionality in low-dimensional quantum materials.

Keywords: ferroelectricity, 2D materials, chromium tellurides, van der Waals magnets



Professor Shu Ping Lau is a Chair Professor in the Department of Physics and Materials at The Hong Kong Polytechnic University and serves as the Associate Director of the Photonic Research Institute. He is a Fellow of the American Physical Society and was named a Highly Cited Researcher by Clarivate in 2023 and 2025. With more than 450 journal publications, Professor Lau's expertise focuses on nanomaterials and energy materials. His current research centers on two-dimensional (2D) materials for multifunctional applications and on electrocatalysis for carbon dioxide capture and conversion.

Dr. Nitu Syed
RMIT University, Australia

Day 2: 16:30-16:45, Invited Talk

Title: Liquid Metal-Derived Two-Dimensional Materials: A New Frontier for Transparent Electronics and Advanced Sensors

Abstract: Liquid metals (LMs) and their alloys provide a versatile platform for the synthesis of two-dimensional (2D) materials through spontaneous interfacial reactions occurring at the liquid metal-gas interface under ambient conditions.[1] The growth of surface oxides follows the self-limiting Cabrera–Mott oxidation process, resulting in the formation of atomically smooth and ultrathin oxide layers that are weakly bound to the parent liquid metal. These layers can be readily exfoliated and transferred onto a variety of substrates, offering a scalable, and vacuum-free alternative to conventional thin-film fabrication techniques.[2] Recent advances in this field have enabled the synthesis of a diverse family of 2D materials spanning a significant portion of the periodic table. In this presentation, we demonstrate the synthesis of ultrathin 2D metal oxides, including In_2O_3, SnO_2, ITO, and alloy-derived mixed-metal oxides, with thicknesses below 5 nm. Structural, optical, and electronic characterization reveal excellent film uniformity, high optical transparency (>97%), and tunable electronic properties suitable for applications in transparent electronics, photodetectors, transistors, and gas sensors. Beyond oxide materials, liquid metal-derived nanosheets can be transformed into a range of functional compounds, including metal nitrides, sulfides, and phosphates, significantly expanding the accessible material library for energy, environmental, and sensing technologies. Furthermore, alloy engineering provides a powerful route for tailoring material composition and functionality. By controlling alloy chemistry, such as Zn–Sn, In–Sb, and In–Sn systems, the oxidation behaviour, defect chemistry, and electronic structure of the resulting nanosheets can be systematically tuned. This capability opens new opportunities for developing next-generation transparent conducting oxides (TCOs), transparent semiconducting oxides (TSOs), and multifunctional nanomaterials. As a representative example, liquid metal-derived SnO_2 nanosheets exhibit outstanding multifunctional sensing capabilities, demonstrating high responsiveness to UV light for optical sensing and excellent sensitivity and selectivity toward NH_3 detection at room temperature. By combining electrical bias, UV photoactivation, and temperature modulation as external stimuli, sensor performance can be further enhanced, enabling NH_3 detection at concentrations as low as 5 ppm with promising limits of detection. The ultrathin nanosheets also display distinctive cross-selective responses toward a range of organic and inorganic gases, highlighting their potential as versatile sensing platforms for environmental monitoring and healthcare diagnostics. Overall, this work establishes liquid metal chemistry as a scalable and versatile manufacturing platform for atomically thin functional materials. By bridging fundamental interfacial science with practical device engineering, liquid metal offer exciting opportunities for transparent electronics, optoelectronics, flexible devices, and advanced sensors.

Key Words: Liquid metals; Two-dimensional materials; Ultrathin metal oxides; Gas sensing; Transparent electronics; Optoelectronics.

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Dr Nitu Syed is a Vice-Chancellor's Research Fellow in the School of Engineering at RMIT University and an Associate Investigator with the ARC Centre of Excellence for Transformative Meta-Optical Systems. She holds a PhD in Electronic Materials Engineering from RMIT University and was previously a McKenzie Research Fellow at the University of Melbourne. Her research focuses on liquid metal-based synthesis and advanced functional materials for nanoelectronics, environmental sensing, and optoelectronics. She has published in leading journals, including Nature Electronics, Nature Communications, Advanced Functional Materials, and ACS Nano. She was recognition as one of Australia's 30 Most Innovative Engineers.

Dr. Morgan Huihui Zhang
RMIT University, Australia

Day 2: 16:45-17:00, Invited Talk

Title: Light-enabled High-performance Graphene for Energy Devices, Wearable Textiles and Beyond

Abstract: Graphene – a 2D material with exceptional optical, electrical, and thermal properties – is emerging as a universal photothermal platform for sustainable technologies[1–3]. By efficiently converting light into localized heat, graphene enables performance breakthroughs across energy devices, wearable textiles, and environmental applications[4,5]. Herein, we highlight two complementary advances. First, a flash-enabled graphene design is introduced for photothermal-enhanced supercapacitors. Prepared within milliseconds by a sustainable flash reduction process, the graphene electrodes and photo-absorber layers deliver rapid heating to ~50 °C under sunlight, enhancing ion transport kinetics and achieving up to 65% improvement in capacitance and energy density[6]. This scalable approach offers a green pathway to overcome performance bottlenecks in next-generation energy storage devices. In addition, graphene-coated smart fabrics are developed via a universal layer-by-layer coating strategy, yielding uniform, firmly adhered, and tunable coatings on natural cotton[7]. The fabrics demonstrate multifunctionality, including precise thermal regulation, dynamic temperature sensing for health monitoring, and robust photothermal heating for self-warming. Furthermore, their strong photothermal effect enables solar-driven water purification and desalination, providing practical solutions for freshwater generation in outdoor and survival scenarios. These results establish graphene's photothermal effect as a unifying strategy for energy devices, wearable electronics, and beyond, paving the way toward scalable, multifunctional, and sustainable applications.

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Dr Morgan Huihui Zhang is an ARC Early Career Industry Fellow at RMIT University, specialising in graphene materials, printed electronics and light-driven nanomanufacturing. Their research focuses on translating advanced materials into practical technologies, including self-powered wearable sensors, epidermal electronics, graphene-based energy storage and solar-driven water purification. They have led nearly AUD 1 million in competitive research funding and received multiple awards for research excellence and technology translation. Their current work integrates scalable manufacturing, energy harvesting, sensing and graphene devices to develop next-generation self-powered systems for healthcare, energy and sustainable technologies.

NextGEM26

THE INTERNATIONAL SYMPOSIUM ON
NEXT-GENERATION ENERGY MATERIALS AND DEVICES

28 – 30 SEPTEMBER 2026 | GOLD COAST, AUSTRALIA

Day 3

Wednesday, 30 September 2026

Room 1: Catalyst 6A

Prof. Shaobin Wang
Adelaide University, Australia

Day 3: 9:00-9:20, Keynote Talk

Title: Carbon-based Materials for Photocatalytic Energy Conversion

Abstract: Currently, we are facing many issues such as energy shortage and environmental pollution.[1,2] Advanced materials and catalytic reactions provide good solutions to address the issues for clean energy production, chemical synthesis and environmental remediation. As one of the emerging green applications, metal-free nanocarbons have demonstrated promise as effective catalysts for green technologies to overcome the poor stability, undesirable metal leaching and environmental toxicity in metal-based catalytic processes. Fossil fuels are the most intensive energy supply for the world, however, their combustion will generate large amount of CO2 and toxic gases as well as particulates, causing climate changes and air pollution. In fact, solar light is sustainable energy and can be used for driving reactions toward generating other clean energy like H_2 and electricity.[1] Meanwhile, emerging organic contaminants are largely released from various industrial processes into water and their removal from water urges for energy-saving, clean and efficient water treatment technologies. Advanced oxidation processes (AOPs) have been widely applied in water/wastewater remediation.[2,3] Herein, we showcase our recent contributions to metal-free catalysis in advanced oxidation for water remediation, electrochemical conversion and photocatalytic reactions for energy conversion and chemical synthesis, discussing the intrinsic active sites, reaction mechanisms and perspectives for future applications.[1-4]

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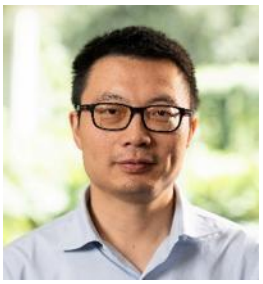
Prof. Shaobin Wang obtained the degrees of BSc and MSc in Chemistry from Peking University and PhD in Chemical Engineering from the University of Queensland (Australia). He has been a John Curtin Distinguished Professor at Curtin University (Australia) and is now a Laureate Professor at the School of Chemical Engineering, Adelaide University (Australia). His research interests focus on nanomaterial synthesis and application for adsorption and catalysis, fuel and energy conversion and environmental remediation. He was awarded 2012 Thomson Reuters Citation & Innovation Awards in Australia and is listed as a highly cited researcher in Engineering, Chemistry and Environment & Ecology in 2016-2022. He is a co-editor of Journal of Colloid and Interface Science and an editor of Applied Catalysis B: Environmental as well as an editorial board member of several international journals

Prof. Zhaojun Han
Eastern Institute of Technology, China

Day 3: 9:20-9:40, Keynote Talk

Title: Novel electrocatalyst designs for green hydrogen

Abstract: Green hydrogen via water splitting is a promising energy source to phase out fossil fuels. However, renewable powers such as solar and wind are intermittent, unstable and unpredictable, posing challenges to directly use them for green hydrogen production. In this talk, I will introduce several approaches that can improve the performance and reduce the cost of electrocatalysts in a range of electrolyte conditions, including Pt single-atom catalysts anchored on vertical graphene support for alkaline hydrogen evolution reactions (HER), Cr-coated non-precious NiMo nanowires for alkaline HER, Ru active sites on amorphous Ni-doped MoO3 nanowires, and metal-doped Co2MnO4 spinel structures for acidic oxygen evolution reactions (OER). Our approaches deepen the understanding of metal electrocatalysts in green hydrogen, paving the way for widespread applications of industrial electrolysis under different conditions.



Biography: Zhaojun Han is currently a Professor at Eastern Institute of Technology, Ningbo, China, since 2025. He was a Principal Research Scientist at Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, and held academic positions at the University of New South Wales (UNSW) and Queensland University of Technology (QUT) between 2019 and 2025. His research focuses on developing low-dimensional functional materials to tackle the challenges in materials, energy and environmental science. He has published ~200 peer-reviewed papers with a total citation of ~14,000 and an H-index of 68. He is the recipient of multiple awards and honours including Fellow of Royal Society of Chemistry (FRSC), ARC Future Fellowship, the inaugural 40 under 40 Most Influential Asian-Australian, and ARC Discovery Early-Career Researcher Award (DECRA).

Dr. Yonggang Jin
CSIRO, Australia

Day 3: 9:40-10:00, Keynote Talk

Title: CSIRO Research and Development in Mine Methane Mitigation

Abstract: Methane contained in mine ventilation air, known as ventilation air methane (VAM), is a major source of fugitive emissions from underground coal ming, accounting for approximately 15% of Australia's total methane emissions. This paper presents CSIRO's research and development efforts in VAM abatement over the past two decades, highlighting four high Technology Readiness Levels (TRL 6-7) technologies that have been successfully demonstrated with actual VAM at mine sites:

- VAMCAT: A novel catalytic gas turbine system capable of operating with methane concentrations as low as 0.8% for power generation
- VAMMIT: A compact thermal flow reversal reactor featuring a novel regenerative bed for self-sustaining destruction of ≥ 0.3% methane
- VAMCAP: A VAM capture system employing CSIRO-developed carbon composite adsorbents and a two-stage temperature and vacuum swing adsorption (TVSA) process for methane enrichment
- CataVAM™: a catalytic flow reversal reactor with a high-performance catalytic regenerative bed designed for self-sustaining destruction of as low as 0.1% methane, optimised for the 0.2-0.4% methane range typical of Australian VAM conditions

Beyond these high TRL technologies, CSIRO has also explored emerging technologies such as photocatalytic oxidation for ultralow diffusive methane sources, and novel low-cost transition metal oxides catalysts for catalytic methane mitigation. The paper further updates recent results from successful site trials of the CataVAM™ pilot unit at a mine in NSW. The system demonstrated efficient self-sustaining destruction of low concentration VAM, achieving over 98% methane destruction efficiency across ventilation air flow rates up to 1.38 Nm^3/s and 0.15 to 0.5% CH_4. Operating at low temperatures (450-650 ^oC), while maintaining high flow capacity and low pressure drop, the technology offers significant cost-effectiveness and reduced operational risk. Central to the CataVAM™ performance is a proprietary honeycomb-shaped catalytic regenerative bed, designed to optimise the coupling of catalytic performance, heat transfer and flow dynamics.

Keywords: Methane abatement, Ventilation air methane, Regenerative thermal oxidation, Catalytic mitigation, Methane capture

Biography: Dr Yonggang Jin is a Senior Principal Research Scientist, and the Team Leader of Environment and Sustainability within the Advanced Mining Technologies Research Program, Mineral Resources Research Unit at CSIRO. Yonggang has over 20 years research experience in developing functional nanomaterials and innovative processes for adsorption, separation, catalytic/photocatalytic and electrochemical applications in energy and resources sectors. His current research primarily focuses on methane emissions abatement, carbon capture and utilisation, and dust monitoring and control particularly related to respirable silica dust. He leads CSIRO's world-leading research and development in ventilation air methane abatement. Yonggang has a strong track record in government and industry engagement and in leading large complex projects involving prototype development, field trials and demonstration.

Dr. Wenhao Ren
School of Chemical Engineering, Adelaide University

Day 3: 10:00-10:15, Invited Talk

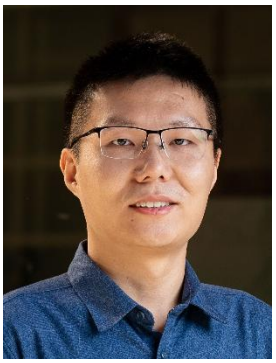
Title: Engineering Reaction Interfaces in Catholyte-Free CO2/CO Electrolysers

Abstract: Electrochemical CO_2 reduction holds significant promise for carbon recycling and energy storage. The microenvironment at the interface structure can substantially influence the activity and selectivity of the reaction. However, the interface structure in a catholyte-free membrane electrode assembly (MEA) electrolyzer remains underexplored.

Here, we investigate CO_2/CO reduction across different cell configurations and uncover the unique quasi two-phase interfaces present in the MEA electrolyzer. Three key aspects of the electrocatalytic reaction interfaces are examined: (*i*) the effect of K^+ at the electric double layer; (*ii*) the mass transfer of H_2O from the anolyte to the cathode, providing protons; and (*iii*) the mass transfer of OH^- from the cathode to the anode in the catholyte-free system.

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4 Ren, W. *et al.* Field-enhanced CO electroreduction in membrane electrolyzers at a dehydrated interface. *Chem* **11**, 102352, (2025).



Dr. Wenhao Ren is currently a DECRA research fellow at the Adelaide University. His research focuses on electrochemical CO_2 conversion and electrolyser design. In particular, his work aims to bridge fundamental understanding of catalytic materials and interfaces with their performance under practical electrolyser operating conditions. He has published over 50 high-quality refereed journal papers, containing 2 ESI Hot papers, 6 ESI Highly Cited papers. These include 21 papers as the first/corresponding authors, including *Joule, Nat. Commun., Chem, JACS, Angew. Chem. Int. Ed.,* etc. He has achieved an h-index of 42 and total citations of > 8,000. Dr Ren has also been involved in several industrial projects and has contributed to five granted patents.

Dr. Qingfeng Zhai
University of New South Wales, Australia

Day 3: 10:15-10:30, Invited Talk

Title: Probing the active site of carbon-based catalysts through EC-STM

Abstract: Active sites in catalysts play key roles in determining their efficiency and reaction pathways in electrochemical reactions.1 Probe and confirm the active sites in catalyst is important to design and synthesize the high-efficient catalysts for specific applications. Electrochemical scanning tunneling microscopy (EC-STM) offers a direct, atomic-scale method to probe these active sites, enabling real-time observation of surface structures and electronic properties under operational conditions.2,3 In my study, I utilize EC-STM to explore the active sites of carbon-based catalysts, revealing the key structure-activity relationships.3 Further, it can provide critical insights into the mechanism of electrochemical processes, advancing the rational design of carbon-based materials for various applications.

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Dr Qingfeng Zhai is a Lecturer and ARC DECRA Fellow at the School of Chemical Engineering, UNSW Sydney. He received his PhD from the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, and subsequently completed postdoctoral research at Monash University and UNSW. His research focuses on functional carbon-based nanomaterials for electrocatalysis and electrochemical sensing. He combines advanced in situ electrochemical scanning tunnelling microscopy (EC-STM) with electrochemical techniques to reveal catalytic mechanisms at the atomic scale and to develop high-performance catalysts for sustainable energy conversion, green chemistry, and healthcare applications.

Room 2, Solar 5

Prof. Trystan Watson
Swansea University, UK

Day 3: 09:00-09:20, Keynote Talk

Title: Democratising Perovskite Photovoltaics: Roll-to-Roll and Carbon-Based Routes to Low-Capex Solar Manufacture

Abstract: Perovskite photovoltaics have reached efficiencies competitive with silicon, yet the technology's most important promise is not efficiency but accessibility. Silicon manufacture is concentrated in a handful of gigafactories demanding billion-dollar capital investment, high-temperature processing and ultra-clean facilities — a model that excludes most of the world from producing its own energy hardware. Perovskites, processed from solution below 150 °C, offer a fundamentally different manufacturing paradigm: one that can be distributed, low-capex and locally owned. This talk describes work at Swansea University to make that paradigm real, along two converging routes. The first is roll-to-roll (R2R) slot-die coating, where we have demonstrated the first fully R2R-printed perovskite device stack, replacing vacuum-evaporated gold with a solution-processed carbon electrode and removing every vacuum step from the process chain [1,2]. The second is screen-printed triple-mesoscopic carbon devices, in which perovskite is infiltrated into a printed scaffold — a route needing little more than screen printers and box furnaces, with modules of over 500 cm² active area now surviving twelve months of outdoor exposure. I will then address the constraint that quietly dominates the cost of any PV factory: the cleanroom. We have quantified how airborne particulates actually affect planar and printed perovskite devices, and find performance far more tolerant of dust than the industry assumes [3]. Manufacture outside a controlled environment is not a compromise to be excused but a design target to be engineered towards. Taken together, low-temperature solution processing, carbon electrodes, non-halogenated inks and cleanroom-free tolerance define a manufacturing envelope that a modest facility almost anywhere could occupy. I will close on what still stands in the way — in-line metrology, yield, interconnection and lifetime — and on what a genuinely democratised solar supply chain needs from the research community.

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Biography: Trystan Watson is Professor and Head of Materials Science and Engineering at Swansea University, and Photovoltaics Scale-up Research Lead at the SPECIFIC Innovation and Knowledge Centre. He read Chemistry at Swansea before completing an Engineering Doctorate in steel technology, and worked as a product development engineer at Corus/Tata Steel before returning to research in 2007. A Chartered Engineer (IOM3), he has published over 200 papers on the manufacture of printed photovoltaics. His group demonstrated the world's first fully roll-to-roll printed perovskite solar cell, and works across slot-die coating, carbon electrodes and cleanroom-free, low-capex module manufacture.

Assoc. Prof. Shi Chen
University of Macau, Macau

Day 3: 09:20-09:40, Keynote Talk

Title: Interfacial characterization and engineering for high performance perovskite optoelectronic devices

Abstract: Halide perovskite optoelectronic devices have attracted great research interests in recent years. Among various improvement strategies, interfacial engineering appears as the one still holding many potentials in device performance optimization. At the lower interface, we studied the energy level alignment of SAM molecules on ITO substrates. Our study reveal the orientation of SAM will directly affect the energy level at the interface. At the upper interface, 2D perovskite passivation layer show great promise due to its compatibility and excellent water resistance. However, the 2D perovskite layer is prone to thermal degradation due to diffuse of large 2D cations into 3D perovskites. Here, we reported an organic cation which evolves from n=1 2D perovskite into 1D perovskite, greatly reduced the degradation of passivation layer. The device could achieve T_{80} for 1000 hours at 85°C with best performance of 25.6%.

Keyword: interface, perovskite solar cell, self assembly monolayer

Assoc. Prof. Murad Tayebjee
UNSW, Australia

Day 3: 09:40-10:00, Keynote Talk

Title: Singlet Fission on Silicon Solar Cells

Abstract: Silicon photovoltaics dominate the global solar market, but conventional single-junction silicon cells are approaching their practical efficiency ceiling. Tandem architectures offer one route beyond this limit, yet they introduce significant challenges in current matching, fabrication complexity, spectral sensitivity, and large-scale manufacturability. Singlet fission offers an alternative pathway: a molecular photophysical process in which one high-energy photon generates two triplet excitons, potentially allowing two electron–hole pairs to be produced from a single absorbed photon. When coupled to silicon, this process can increase photocurrent while preserving the simplicity, scalability, and reliability advantages of single-junction silicon technology. In this talk, I will outline the operating principles of singlet fission-enhanced silicon photovoltaics and compare two leading device concepts: radiative optical coupling, in which triplet energy is converted into photons that are reabsorbed by silicon, and direct energy transfer, in which triplet excitons transfer energy directly into the silicon cell.1 I will discuss why singlet fission is attractive from a manufacturing perspective, including its compatibility with existing silicon platforms, its potential use as an added optical or interfacial layer, and the low material cost and scalability of organic chromophores. I will also highlight the key scientific and engineering challenges, particularly stable singlet fission materials, efficient triplet transfer, and preservation of silicon surface passivation. Recent demonstrations of photocurrent enhancement and energy transfer using more stable chromophores2 suggest that these barriers are increasingly tractable, positioning singlet fission as a scalable route toward high-efficiency silicon photovoltaics.

Keywords: singlet fission, silicon solar cells, downconversion, tandem solar cells

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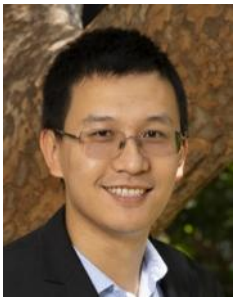
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Asst. Prof. Chang Yan
Hong Kong University of Science and Technology, HongKong

Day 3: 10:00-10:15, Invited Talk

Title: Efficient wide bandgap Copper Indium Gallium Sulfide solar cell by solution methods

Abstract: Copper-based sulfide $CuInGaS_2$($CIGS_2$) is a promising thin film photovoltaic technologies with the merit of excellent optoelectronic properties and a wide Eg of 1.5eV-1.7eV. They have great potential use as a flexible, semi-transparent solar cell as well as a promising top cell candidate for a two-junction Si-based tandem cell. However, the traditional efficient $CIGS_2$ solar cells are deposited using an expensive vacuum-based method. In this work, we demonstrate that, by using simple and cost-effective solution methods, efficient can also be achieved. Based on the sol-gel method, a novel approach is proposed utilizing double-zone temperature sulfurization to control the sulfur atmosphere and sample temperature independently. With this strategy, the optimized sulfurization condition manages better crystallization and a lower defect density for the $CIGS_2$ absorber layer. By a further interface engineering using a ZnSnO electronic transport layer, a certified 14.5% efficiency solution processed $CIGS_2$ with Eg of 1.66eV has been achieved.



Biography: Dr. Chang YAN has been an assistant professor in the Sustainable Energy and Environment Thrust at Hong Kong University of Science and Technology (Guangzhou) since 2022. He was awarded PhD degree in Photovoltaic Engineering from UNSW in 2017. Then he worked as a postdoc and lecturer at UNSW before his appointment at HKUST(GZ). His current research interest focuses on developing the next generation of inorganic solar cells, such as chalcogenide, kesterite, and Si-based tandem solar cells (e.g., perovskite/Si tandem). He is also interested in using Artificial Intelligence and automation robots to accelerate R&D for future solar cell materials and devices. He was included in the top 2% list of global applied physics scientists assessed by standardized citation metrics in the single year of 2024.

Saveen Senanayake
Queensland University of Technology, Australia

Day 3: 10:15-10:27, Oral Talk

Title: Unravelling the Role of Indium in Enhancing the Stability of Mixed Tin–Lead Perovskite Solar Cells

Abstract: Tin–lead (Sn–Pb) metal halide perovskites have emerged as promising light-harvesting materials for high-efficiency solar cells due to their tunable bandgap (1.2–1.4 eV), which is well suited for single-junction and tandem photovoltaic applications. Furthermore, their reduced lead content offers a less toxic alternative to conventional lead-based perovskite solar cells (PSCs). However, the practical deployment of Sn–Pb PSCs is severely hindered by the instability of Sn^{2+}, which readily oxidizes to Sn^{4+}, leading to increased defect formation, accelerated degradation, and reduced device lifetime. In this work, indium(III) iodide (InI_3) is introduced as a additive to enhance the structural stability and photovoltaic performance of Sn–Pb perovskites. The incorporation of indium is found to facilitate partial substitution of Sn^{2+} within the perovskite crystal lattice, resulting in a more robust and chemically stable crystal structure. Consequently, InI_3-modified perovskite films exhibit improved crystallinity, enhanced surface morphology, and reduced defect density compared with the control films. Optoelectronic characterization reveals that indium incorporation effectively suppresses trap-assisted recombination and lowers non-radiative carrier losses, contributing to improved charge-carrier dynamics within the perovskite layer. These material improvements translate into enhanced photovoltaic performance, with the power conversion efficiency increasing from 17.2% for the control devices to 18.1% for the InI_3-treated devices. In addition to performance enhancement, the incorporation of InI_3 significantly improves the environmental stability of Sn–Pb perovskite films. The modified perovskites demonstrate superior resistance to degradation under elevated temperatures and humid atmospheric conditions, indicating improved tolerance against common environmental stressors. This work highlights the effectiveness of indium-based lattice engineering as a viable strategy for simultaneously improving the efficiency and operational stability of Sn–Pb perovskite solar cells, advancing their potential for practical photovoltaic applications.

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Room 3: Optoelectronic 2

Prof. Guichuan Xing
University of Macau, Macao S.A.R. 999078, China

Day 3: 09:00-09:20, Kenote Talk

Title: Breaking the Efficiency Trade off in Visible Perovskite Photovoltaic Light Emitting Diodes

Abstract: The convergence of energy harvesting and light emission in a single semiconductor device promises revolutionary applications, from self powered displays and adaptive smart windows to autonomous sensors and Internet of Things nodes. Metal halide perovskites are ideally suited for such bifunctional photovoltaic light emitting diodes (PV LEDs) owing to their exceptional optoelectronic properties. However, realizing this dual functionality in the visible spectrum, particularly in green & red emitting wide bandgap perovskites, has remained a formidable challenge. The root cause lies in a fundamental materials conflict: robust defect passivation, essential for bright electroluminescence, inevitably impedes charge transport, while optimizing for photovoltaic efficiency compromises radiative recombination. This tradeoff has severely limited the performance of visible PV LEDs, keeping both photovoltaic and electroluminescent efficiencies far below practical thresholds. In this talk, we present our recent progress in overcoming this long standing bottleneck through a combination of tailored material optimization and rational device architecture design. We will introduce an interface engineering strategy that decouples the conflicting processes of defect passivation and charge transport, allowing each function to operate optimally without compromising the other. By carefully designing the interfacial layers, we achieve efficient suppression of nonradiative recombination while maintaining unimpeded carrier extraction and injection. Our green & red emitting bifunctional devices exhibit simultaneously high photovoltaic power conversion and electroluminescent external quantum efficiencies, with open circuit voltages approaching the thermodynamic limit and luminance levels suitable for real world applications. Furthermore, we will demonstrate the scalability of our approach to large area modules and pixelated arrays, and showcase energy autonomous operation where the device harvests solar energy and subsequently powers its own light emission. We will also discuss the potential of this platform for next generation self powered displays, smart windows, and integrated optoelectronic systems, highlighting the generalizability of our interfacial design principle for other material systems.



Prof. Guichuan Xing is a Professor at the Institute of Applied Physics and Materials Engineering, University of Macau (UM), and serves as the Department Head of Physics and Chemistry at the Faculty of Science and Technology. He received his Ph.D. in Physics from the National University of Singapore in 2011 and worked as a research fellow at Nanyang Technological University from 2009 to 2016 before joining UM in 2016. His research focuses on ultrafast laser spectroscopy, nano optoelectronics, and metal halide perovskites for light harvesting and light emission. He has published over 300 peer-reviewed papers with more than 45,000 citations. He received the Second Prize of the Macao Natural Science Award in 2022

Prof. Glenn Solomon
Adelaide University, Australia

Day 3: 09:20-09:40, Keynote Talk

Title: Optimising the optical properties of single, semiconductor quantum dots for quantum technologies using an epitaxial growth process

Abstract: As optical-based quantum technologies evolve, the need for bright and efficient quantum light sources becomes more consequential. Solid-state light sources are a good choice for most quantum technologies applications. They are made from either nonlinear materials, where their nonlinear optical processes produce quantum light, or 0D emitters, such as defect-related centers or the topic of this work, quantum dots (QDs), that are formed from roughly 10^5 atoms. For the last 25-plus years, QDs produced through InAs-related strained-driven epitaxy have been used with good results but also have shortcomings. An emerging alternative is discussed here that focuses on alleviating these shortcomings. Here, we discuss our results on fabricating QDs with no strain and with the ability to produce single photons at a variety of wavelengths [1]. We use a QD growth process called droplet-etched epitaxy (DEE) to fabricate GaAs-based QDs in an AlGaAs background. These QDs emit single photons at 4K in the 725-800 nm range. Their growth process is governed by well-know surface physics and is well-controlled, leading to predictable optical emission wavelengths. Compared with the traditional strain-driven growth process, DEE may offer more flexibility in material combinations, leading to quantum light emission at a variety of wavelengths depending on material choice. We will discuss this flexibility. We will close with a discussion of the broader impact of strain-free QDs. Due to the lack of strain and the high structural symmetry, these QDs are expected to have lower excitonic fine-structure splitting, a necessary feature to create an entangled light source using what is commonly known as an atomic-like cascade process. In addition, the lack of strain and strain gradients in these QDs should produce QD spin states with longer coherence times than those created with the former growth process.

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Glenn Solomon is the Hicks Chair in Quantum Materials at Adelaide University where he is in Physics in the College of Sciences, and a member of the institute, IPAS. His research is at the nexus of physics and engineering, where he mostly focuses on solid-state physics and nanophotonics. Prof. Solomon is the director of the ARC ITTC on Current and Emergent Quantum Technologies. He is a fellow of the American Physical Society and a fellow of Optica.

Dr. Mile Gao
University of Queensland, Australia

Day 3: 09:40-10:00, Invited Talk

Title: Characterising Charge Carrier Dynamics in Organic Optoelectronic Devices

Abstract: Charge transport is a key factor governing the performance of organic optoelectronic devices, including organic light-emitting diodes (OLEDs) and organic photovoltaic (OPV) devices. However, accurately determining charge carrier mobility in thin-film device structures remains challenging due to limitations of conventional characterisation techniques. I will present a series of advanced charge transport characterisation methods based on the Charge Extraction by Linearly Increasing Voltage (CELIV) framework, including Metal Insulator Semiconductor (MIS)-CELIV, photo-MIS-CELIV, and injection-CELIV, etc1. These techniques enable the independent measurement of electron and hole mobilities in diode-like device architectures as well as charge carrier densities, charge generation efficiency, charge balance, and recombination processes under device-relevant operating conditions. These methods therefore offer valuable insights into the fundamental mechanisms that are difficult to obtain using traditional space-charge-limited current or time-of-flight approaches. Another advantage of these methods is that they are highly transferrable as validated by their successfully applications in multiple optoelectronic systems. In particular, future developments may enable the investigation of coupled electronic and ionic transport in emerging materials such as metal-halide perovskites, where ion migration plays a critical role in device performance, stability, and hysteresis2. Consequently, advanced CELIV-based approaches provide a promising platform for studying charge carrier dynamics in next-generation energy conversion and optoelectronic devices.

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Dr. Mile Gao is an ARC DECRA Fellow at The University of Queensland, Australia. His research focuses on understanding charge generation, transport, and recombination in semiconductor optoelectronic devices through the development of advanced electrical characterization techniques. His work combines device physics with innovative transient measurement methods to reveal the fundamental processes governing device operation. His current research expands these techniques to emerging semiconductor systems, including perovskite photovoltaics and other next-generation optoelectronic devices.

Weilun Li
Monash University, Australia

Day 3: 10:00-10:12, Oral Talk

Title: Twinning in Halide Perovskites: Atomic Structures and Impacts on Photophysical Properties

Abstract: Crystal twinning is a common structural phenomenon in materials, including halide perovskites. Twin boundaries are often regarded as extended defects that disrupt lattice continuity, modify local strain fields, and influence charge transport and phase stability. However, twin boundaries can also generate local symmetry breaking, polarity, or electronic structure that are absent in the parent crystal. Understanding when twinning is detrimental and when it can be beneficial is therefore essential for the rational design of halide perovskite semiconductors [1]. Compared with oxide perovskites, where the structure, properties, and engineering of twin boundaries has been extensively studied, twin boundaries in the much younger field of halide perovskites remain relatively underexplored. This is largely due to the beam-sensitive nature of halide perovskites, which makes direct atomic-scale characterization particularly challenging. In this presentation, I will discuss our recent work on identifying and understanding twin defects in photoactive halide perovskites using advanced low-dose transmission electron microscopy. First, I will present our discovery of twin defects in hybrid $FAPbI_3$ nanocrystals, where the atomic structure of twin boundaries was directly resolved and correlated with photovoltaic performance and stability [2]. In this case, twinning acts as a detrimental structural defect by locally transforming the original cubic phase into a hexagonal configuration, thereby negatively influencing device-relevant properties. Second, I will discuss our atomic observations of ferroelastic twin boundaries in all-inorganic $CsPbI_3$ and $CsPbBr_3$. In contrast to the detrimental twin defects in cubic $FAPbI_3$, these ferroelastic twins create polar structures within an otherwise non-polar bulk lattice, potentially contributing to ferroelectric-like behaviour [3, 4]. These findings highlight the dual role of twinning in halide perovskites: it can serve as sources of structural instability and performance loss, but it might also act as a new structural element for functionality through local structural variations. Overall, this work demonstrates that twin boundaries should not be viewed simply as crystallographic imperfections. Rather, they represent atomically confined nano-structures whose impact depends strongly on their local atomic configurations. By resolving these structures directly and correlating them with photophysical behaviour, we provide new insights into how extended defects can be understood, controlled, and exploited in halide perovskite materials.

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Oliver Lindsay
Centre for Organic Photonics & Electronics, School of Chemistry and Molecular Biosciences,
The University of Queensland

Day 3: 10:12-10:24, Oral Talk

Title: In situ measurement of film formation for homojunction OPV films with volatile processing additives

Abstract: The use of volatile processing additives in solution-processed homojunction organic photovoltaic (OPV) devices has unlocked power conversion efficiencies (PCEs) over 5%.[1] Understanding how these additives improve performance is critical to advancing homojunction devices. Processing additives are known to modify active-layer morphology in both homojunction and bulk heterojunction devices by influencing molecular packing and subsequently enhancing light absorption, charge separation, and charge transport.[2] Film formation with processing additives occurs in two distinct stages: spin-coating and thermal annealing. During spin-coating, additives influence solvent evaporation rates and crystal formation kinetics, resulting in different as-cast morphologies, while during thermal annealing, residual additives within the film are driven off, enabling further molecular rearrangement. Both stages contribute to the final active-layer structure and therefore must be investigated to obtain a comprehensive understanding of morphology evolution. Grazing-incidence wide-angle X-ray scattering (GIWAXS) is well suited to probing molecular packing, and synchrotron sources enable in-situ measurements. While in-situ annealing is well established, in-situ spin-coating remains technically challenging. In this work, in-situ GIWAXS measurements during both spin-coating and thermal annealing were performed at ALBA Synchrotron to track structural evolution throughout the complete film-formation process. Homojunction systems simplify interpretation by avoiding the complexity associated with multi-component blends. Using Y6 as the model semiconductor, seven processing additives were selected to span a range of chemical properties. The results reveal behaviours ranging from subtle additive-dependent changes in crystallinity to distinct shifts in peak positions, indicating molecular packing rearrangement on a ~20 s timescale. These findings demonstrate how processing additives control film-formation kinetics and the resulting morphology, providing insights into strategies for further advancing the performance of homojunction OPVs.

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Room 4: Catalyst 6B

Dr. Jingrun Ran
Adelaide University, Australia

Day 3: 9:00-9:20, Keynote Talk

Title: Atomic-Level Regulation on Photocatalyst for Energy-Related Reaction

Abstract: The global energy crisis and environmental issues impel the aggressive search for a clean and renewable energy source to replace fossil fuels. Hence, conversion of renewable solar energy into clean fuels and valuable chemicals is of great significance. The core challenge of this advanced technology lies in the development of low-cost and environmentally benign photocatalysts with sufficiently high activity and stability. Hence, the rational design and synthesis of photocatalysts at the atomic level (e.g., single-atom and dual-single-atom photocatalyst) to achieve efficient and stable solar-to-chemicals conversion is highly promising. Furthermore, both advanced characterizations (e.g., aberration-corrected atomic-resolution transmission electron microscopy, synchrotron-based X-ray absorption spectroscopy and various in-situ element/space/time-resolved characterizations) and density functional theory based theoretical computations are adopted to investigate the atomic-level structure/composition-performance relationship and mechanism in photocatalysts. The key role of these atomic-level regulation on the activity and selectivity towards H2 evolution, CO2 reduction, reforming plastic and reforming biomass are exhibited. Finally, a universal rule to develop high-performance photocatalysts for efficient solar-to-chemicals energy conversion is concluded.

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Biography: DR. Jingrun Ran is a ARC Future Fellow and senior lecturer at school of chemical engineering in Adelaide University. He was awarded with the ARC Future Fellowship and DECRA Fellowship. His research is focused on atomic-level design/preparation of photocatalysts for producing energy fuels and value-added chemicals. He has been recognized as a Clarivate Highly Cited Researcher in 2020-2025. He is awarded the ACS Energy & Fuels "Rising star" in 2025. He has published 85 papers in well-renowned journals, including Nat. Commun., Adv. Mater., Angew. Chem. Int. Ed., J. Am. Chem. Soc., Sci. Adv. (over 22712 citations, h-index: 50).

Prof. Zhenguo Huang
University of Technology Sydney, Australia

Day 3: 9:20-9:40, Keynote Talk

Title: Hydrogen-rich bond (N-H, O-H, and B-H) for Energy Storage and Transfer

Abstract: Hydrogen-rich systems composed of light elements such as B, C, and N have been extensively explored as hydrogen-storage materials. In this talk, I will first give a brief overview of borohydrides for hydrogen storage, such as room-temperature hydrogen cycling by $LiBH_4$, improved synthesis of $NaBH_4$ and $Mg(BH_4)_2$. I will then discuss reactions between amine–borane complexes and amines that generate high-purity H_2 under ambient conditions. For example, the reaction between ethylenediamine bisborane (EDAB) and ethylenediamine (ED) yields unique B–C–N five-membered rings in the dehydrogenation product, in which one boron is tri-coordinated by three nitrogen atoms. I will also introduce 1,6;2,3-bis-BN cyclohexane—an isostere of cyclohexane with two adjacent BN pairs—which has an attractive hydrogen-storage capacity of >9.0 wt%, nearly twice that of 1,2;4,5-bis-BN cyclohexane. Finally, I will share our latest progress on electrolysis of ammonia/water solutions to produce green hydrogen and nitrite/nitrate, as well as the electrochemical conversion of CO_2 to formic acid.

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Professor Zhenguo Huang is Director of the Centre for Green Technology at the University of Technology Sydney (UTS), where he leads a cross-disciplinary team advancing renewable fuels. His research centres on boron chemistry for energy conversion and storage, spanning hydrogen-storage materials, electrolytes, and 2D boron-containing nanosheets. He has held an ARC DECRA and an ARC Future Fellowship, serves as a Research Advisor at Japan's National Institute for Materials Science, and is a Humboldt Research Fellow (Alexander von Humboldt Foundation). He chairs the International Hydrogen Carriers Alliance.

Dr. Xiaomin Xu

Day 3: 9:40-09:55, Invited Talk

Title: Tuning Cation Nonstoichiometry in Perovskite Oxides for Water and CO2 Electrolysis

Abstract: Electrocatalysts play a central role in electrochemical energy conversion processes, including water splitting and CO_2 electrolysis. Perovskite oxides, with the general formula ABO_3, where A is typically a rare-earth or alkaline-earth metal and B is a transition metal, have attracted considerable attention as low-cost, highly efficient electrocatalysts owing to their compositional and structural flexibility.[1–5] Here, we demonstrate how tuning cation nonstoichiometry enables the development of novel perovskite-based materials, advancing both the fundamental understanding of electrocatalysis and the design of improved electrocatalysts for water and CO_2 electrolysis.[6–10] These findings highlight the versatility of perovskite oxides and the opportunities they offer for the rational design of next-generation electrocatalysts.

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Dr Xiaomin Xu is currently Senior Lecturer at the Curtin Centre for Advanced Energy Materials and Technologies (CAEMT), Western Australian School of Mines (WASM), Curtin University, Australia. He received his PhD degree in Chemical Engineering from WASM, Curtin University in 2021. His research interests focus on the development of functional materials for applications in electrochemical energy storage and conversion

Nazish Aslam
RMIT University, Australia

Day 3: 10:00-10:15, Oral Talk

Title: Dynamic Liquid Metal Catalysts for Acid-Free Biomass Conversion

Abstract: The advancement of biomass valorization for sustainable chemical production relies on catalytic systems capable of replacing conventional acid-driven processes. However, existing platforms are limited by corrosive reaction environments, poor catalyst recyclability, catalyst coking and deactivation, and insufficient control over the dynamic interfacial chemistry that determines catalytic performance. These challenges underscore the necessity for catalytic materials that surpass structural rigidity and facilitate adaptive, non-equilibrium restructuring during reactions. In response, gallium-based liquid metals have been investigated as dynamic catalytic materials for acid-free biomass conversion in deep eutectic solvents, where catalytic function is governed by continuously evolving metal–solvent interfacial states. Catalytic performance was assessed using glucose as a model cellulosic substrate over gallium-based liquid metal systems in both bulk and nanoscale forms. Nanoscale liquid-metal catalysts demonstrated significantly enhanced activity relative to their bulk counterparts, underscoring the importance of interfacial accessibility, surface renewal dynamics, and liquid-state catalytic behavior. A series of low-loading (<5 wt.%) binary and ternary Ga-based alloys incorporating transition metals such as Mn, Co, Cu, Sn, Nb, Ni, Ag, V, Zn, Bi, and Ce were examined to investigate the influence of alloy composition and interfacial chemistry on catalytic performance. Among these, the Ga–Ni–V composition exhibited the highest catalytic performance, selectively producing 5-hydroxymethylfurfural and illustrating the advantageous role of multivalent vanadium in stabilizing electronically heterogeneous and catalytically active surface states. Surface and compositional analyses (XRD, XPS, SEM–EDS, Raman) confirmed a structurally stable yet dynamically evolving Ga–Ni–V interface, characterized by vanadium surface enrichment and the coexistence of metallic and Lewis-acidic oxide domains that influence catalytic activity. The catalyst retained stable performance over four consecutive cycles, demonstrating robust operational stability. Collectively, these results establish gallium-based liquid metals as promising acid-free catalytic platforms for biomass conversion, addressing key challenges of corrosivity, catalyst recovery, and coking, while enabling more sustainable reaction pathways.

Key Words: Liquid metal catalysis; Ga-based alloys; Catalytic interfaces; Dynamic catalytic interfaces Deep eutectic solvent; Biomass conversion; 5-Hydroxymethylfurfural (5-HMF); Glucose dehydration; Acid-free catalytic systems

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Room 5: Battery 5

Prof. Cheng Yan
Queensland University of Technology, Australia

Day 3: 09:00-09:20, Keynote Talk

Title: Chemo-mechanical failure mechanisms in high performance Li-ion batteries

Abstract: Current lithium-ion (Li-ion) batteries do not satisfy the increasing demands of portable electronic devices and electric vehicles, due to low energy densities, safety issues and high cost. High-capacity electrode materials are needed, and researchers have made significant progress over recent years. However, integrating these materials into practical cells has lagged due to several technical challenges. For example, volume expansion of active particles, phase transformation and mechanical stresses generated during cycling may cause cracking, interfacial debonding and poor cycling performance. Up to now, a fundamental understanding of chemistry and mechanics coupling and material failure in high performance batteries is still lacking. In this presentation, we like to report our recent work on investigation of chemo-material failure of electrode materials in high performance Li-ion batteries via operando characterization, mechanical testing, and atomistic modeling. Firstly, we discuss the evolution of microstructure, phase composition, particle size and mechanical stress in Si anodes during charging/discharging cycling and relevant strategies to overcome cracking and pulverization of Si particles [1-4]. Then, we like to report recent work on Ni-rich layered oxide cathodes, including structural evolution, material degradation and possible doping and surface modification techniques to improve the cycling performance and capacity retention [5-7].

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Assoc. Prof. Jianfeng Mao
The University of Adelaide, Australia

Day 3: 09:20-09:40, Keynote Talk

Title: Development of next-generation lithium metal batteries for high energy storage

Abstract: Rapid adoption of clean energy and a wholesale switch to electric transport is key to achieve carbon neutrality. However, current market-dominated lithium-ion batteries (LIBs) cannot meet the needs of automotive and battery manufacturers because the specific energy is rapidly reaching a theoretical limit. More powerful, reliable and safe battery technology is therefore urgently needed for electrification and carbon-neutral energy. Advanced lithium (Li) metal batteries (LMBs) making use of lithium metal anode (3,860 mAh g-1) can significantly increase specific energy of present battery technologies, although instability of the Li metal/electrolyte interface remains a challenge. Regulating the electrode and electrolyte formulation for in-situ construction of robust solid-electrolyte interphase is a practically promising approach. In this talk, I will introduce our recent work on rational electrolyte design and interphase engineering for LMBs [1-3] and will discuss the issues and opportunities for building better batteries.

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Assoc. Prof. Wengui Li
The University of Adelaide, Australia

Day 3: 09:40-10:00, Keynote Talk

Title: Unlocking high energy density in rechargeable cement-based batteries via coating-engineered low-tortuosity pore networks

Abstract: Cement-based materials are an attractive platform for structural energy storage. However, their low energy density remains a fundamental barrier to practical applications because ionic transport through the cementitious matrix is inherently inefficient. This study presents a strategy to engineer the pore network of cement matrix by coating porous aggregates with polyvinyl alcohol (PVA) to overcome this limitation. This coating treatment not only reconstructs the pore network into a highly interconnected, low-tortuosity ionic transport network but also promotes interfacial ion conduction, thereby enhancing the overall effectiveness of ionic transport throughout the cement matrix. The resulting rechargeable cement-based batteries (RCBs) exhibit an ionic conductivity of 20.9 mS cm^{-1} while maintaining a compressive strength of 30 MPa. This enhanced ion transport accelerates electrochemical kinetics, delivering a high energy density of 171 Wh kg-1, together with 79.1% capacity retention after 1,000 charge–discharge cycles at 0.5 A g-1. Moreover, the low-tortuosity cement-based electrolyte ($\tau = 1.8$) demonstrates superior energy-storage performance, underscoring the critical role of interconnected pore networks in facilitating efficient ion transport. The results reveal that pore-network tortuosity governs ion transport efficiency and is a key factor determining the energy density of RCBs. Importantly, the RCBs can charge and power small electronic devices under mechanical loading, highlighting their practical potential in smart infrastructure applications. Overall, engineered aggregate-scale pore network for RCBs provides a scalable approach for developing energy-efficient buildings with integrated energy-storage capability.

Keywords: Cement-based battery; Coating treatment; Energy density; Pore network; Tortuosity; Ion transport



Wengui Li is a Scientia Associate Professor and ARC Future Fellow in the School of Civil and Environmental Engineering at The University of New South Wales (UNSW Sydney), Australia. He received a Joint Doctoral Degree in Structural Engineering from Tongji University, China and Northwestern University, USA in 2013. From 2010 to 2013, he was a Predoctoral Research Fellow at the US NSF-funded Center for Advanced Cement-Based Materials (ACBM) at Northwestern University. Prior to joining UNSW in 2023, he was an Associate Professor at University of Technology Sydney. Wengui received the Humboldt Research Fellowship for Experienced Researchers (Technische Universität Berlin), JSPS Invitational Fellowship (The University of Tokyo), and International Excellence Fellowship of Karlsruhe Institute of Technology (Germany). In 2014, he was awarded an ARC DECRA Fellow. At UNSW, Wengui is the leads the research group "Intelligent Concrete and Infrastructure Materials" (ICIM). The interdisciplinary research team focuses on cement chemistry, advanced concrete technology, energy harvesting and storage, and the development of novel concrete functionalities enabled by nanotechnology

Dr. Junnan Hao
Adelaide University, Australia

Day 3: 10:00-10:15, Invited Talk

Title: Advanced conversion-based cathodes for aqueous Zn batteries

Abstract: Aqueous zinc-ion batteries (ZIBs) are attracting growing attention as safe, low-cost, and environmentally sustainable energy storage systems. Nevertheless, their development has been constrained by conventional intercalation-type cathodes, which rely on Zn2+/H+ co-intercalation. The inevitable participation of H^+ causes electrolyte pH fluctuations and by-product formation, compromising reproducibility and long-term stability. To address these challenges, I pioneered a conversion-type cathode mechanism that avoids H^+ involvement, significantly improving electrochemical stability while broadening the cathode landscape. This concept has been successfully extended to halogen-based systems such as I_2, further demonstrating its versatility. In parallel, I introduced dry electrode fabrication into aqueous batteries for the first time, achieving record areal loadings of over 100 mg cm^{-2}, which is 4–5 times the industrial benchmark of commercial lithium-ion batteries. This breakthrough not only overcomes the limitations of conventional slurry-based processing but also demonstrates the compatibility of aqueous batteries with scalable, high-energy-density electrode manufacturing. Collectively, these advances, from mechanistic innovation to electrode engineering, have accelerated the transition of ZIBs from fundamental laboratory research to practical application, laying a strong foundation for the development of safe, sustainable, and commercially competitive energy storage technologies.

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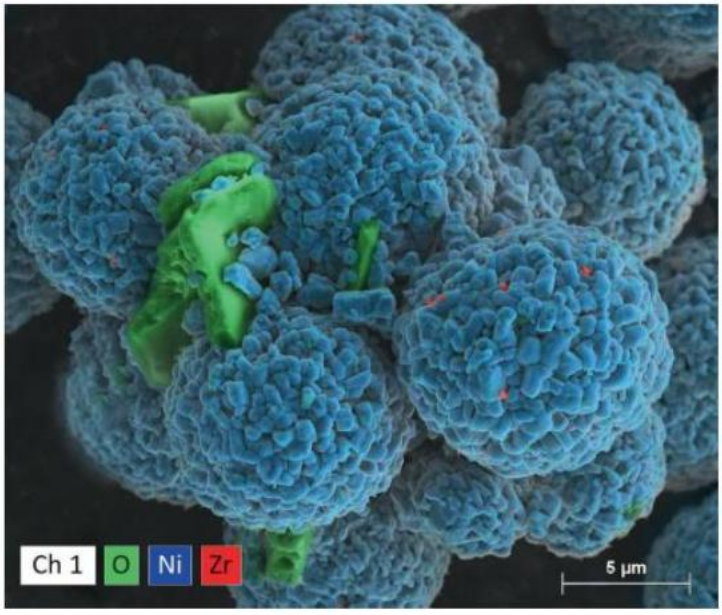
Dr. Junnan Hao is a Senior Lecturer at Adelaide University. His research focuses on energy storage and conversion, particularly aqueous batteries and flexible energy storage devices. He has published >100 peer-reviewed papers, including 32 ESI Highly Cited Papers (top 1% globally). His publications have received >17,500 citations, with an h-index of 66. Dr. Hao has received numerous recognitions and awards, including Clarivate Highly Cited Researcher, ScholarGPS Highly Ranked Scholar, Stanford University World's Top 2% Scientist, JMCA Emerging Investigator, ChemCommun Emerging Investigator Award, the Energy Renaissance Award, and the AINSE Early Career Researcher Excellence Award.

Emily Chen
MP Scientific, Melbourne, Australia

Day 3: 10:15-10:30, Invited Talk

Title: From Microstructure to Chemistry: Advanced Electron Microscopy Characterisation of Battery Materials

Abstract: The performance and degradation of battery materials are governed by their microstructure, composition, and crystallography. Advanced electron microscopy provides a powerful approach to correlating these characteristics across multiple length scales. This presentation will highlight electron microscopy workflows for characterising battery and energy materials, combining high-resolution imaging with elemental mapping, crystallographic analysis, and targeted cross-sectional investigation. Selected case studies will demonstrate how these complementary techniques can reveal phase distributions, grain structures, interfaces, compositional variations, and degradation mechanisms in electrode and battery materials. By connecting microstructure and chemistry with material performance, this integrated characterisation approach provides practical insights into the development and optimisation of next-generation battery materials.



NMC (nickel manganese cobalt) battery precursor material with Zr contamination (red); elemental map with a overlayed SEM image.

Figure 1. Representative EDS elemental mapping of NMC (nickel manganese cobalt) battery precursor material. *Image courtesy of Bruker.*

Room 1: Solar 6

Prof. Yi Zhang
Nankai University, China

Day 3: 10:50-11:10, Keynote Talk

Title: Carrier Transport Regulation Towards Efficient Sb2(S,Se)3 Thin Film Photoelectronic Devices

Abstract: Non-ferrous metal elements display rich properties. Solar cells based on low-valent non-ferrous metal elements, such as $Sb_2(S,Se)_3$, have become an indispensable part of the chalcogenide photovoltaic family. In the past years, the efficiencies of this kind of solar cells have achieved progress. However, there is still a considerable gap compared with its theoretical limits. This is mainly attributed to the special crystalline quality of thin film, the influence of defects such as grain boundaries on carrier transport, as well as interfacial matching issues of the cells. Therefore, the fabrication of $Sb_2(S,Se)_3$ solar cells remains a great challenge. This report presents recent research progress in the preparation of $Sb_2(S,Se)_3$ semiconductor thin film and the improvement of carrier transport efficiency of solar cells.



Prof. Yi Zhang, Director of Institute of Photoelectronic Thin Film Devices and Technology, Nankai University. Prof. Zhang got his PhD from the Institute of Physics, Chinese Academy of Sciences in 2006. He worked as postdoc at the Max Planck Institute for Metals Research in Germany from July 2006 to June 2008, before joining Nankai University as a faculty member in July 2008. His research focuses primarily on metal selenide thin-film solar cells. He has published over 100 peer-reviewed papers, including in Nature Energy. He currently serves on the Photovoltaic Committee, Chinese Renewable Energy Society.

Prof. Jingjing Xue
Guangxi University, China

Day 3: 11:10-11:30, Keynote Talk

Title: Stabilizing Molecule-Based Selective Contacts for Perovskite Solar Cells

Abstract: Molecule-based hole-selective contacts have become essential for high-efficiency inverted perovskite solar cells, yet their operational stability is often constrained by molecular degradation, structural deformation and weak interfacial anchoring. Conventional molecular contacts commonly rely on heteroatom-substituted conjugated cores to ensure charge transport and interfacial selectivity. While electronically effective, these structures may introduce chemically vulnerable sites and compromise molecular integrity under operational stresses. Beyond the molecular skeleton itself, the assembled structure of the molecular contact also presents a stability challenge. Highly ordered molecular packing, although generally considered beneficial for charge transport, can possess well-defined energetic minima and is therefore susceptible to stress-induced structural deformation, aggregation or phase transformation. Even when the molecular structure and packing are optimized, the conventional planar contact architecture still provides only limited interfacial area for anchoring molecules onto the transparent conductive oxide, leaving the molecular layer vulnerable to desorption, migration and interfacial reconstruction during long-term operation.This presentation will summarize our recent efforts to stabilize molecule-based hole-selective contacts across these interconnected levels. We will introduce the design of chemically robust conjugated cores to improve intrinsic molecular stability, the use of orthogonal molecular skeletons to create stress-tolerant amorphous contacts, and the construction of bulk nano-heterointerfaces to strengthen molecular anchoring beyond the conventional planar interface. Together, these studies establish a molecular-to-architectural design framework for stabilizing hole-selective contacts and provide new principles for durable perovskite photovoltaics.

Keywords: selective contacts, stability, perovskite solar cells

Assoc. Prof. Paul Shaw
University of Queensland, Australia

Day 3: 11:30-11:45, Keynote Talk

Title: Performance optimization of Y6 homojunction organic solar cells

Abstract: Non-fullerene small molecule acceptor (NFA) materials have enabled bulk heterojunction (BHJ) organic photovoltaic (OPV) devices to exceed 20% power conversion efficiency (PCE). However, BHJ film morphology can be challenging to reproduce and scale up for commercial manufacturing. Single material active layer or homojunction architectures could significantly simplify the large-scale fabrication process, but solution-processed homojunction OPV devices have typically achieved only modest PCEs of <1.5%. Recent studies of the optoelectronic properties of the NFA Y6 have described its capability to achieve spontaneous free charge generation, making it a strong candidate for improving homojunction device performance. I will present the results from our investigation into how the device architecture can be optimized for Y6 homojunction OPV performance. We find the choice of the charge transport layers to be critical to ensuring efficient charge extraction from the Y6 layer, with maximum PCEs exceeding 2.5%.[1] The PCE was further improved up to 5.4% through control of the Y6 active layer nanostructure via the use of additives – the highest reported efficiency for any solution-processed small molecule homojunction OPV device to date.[2] Finally, I will describe how Y6 homojunctions can be used as testbed for evaluating processing additives and understanding how they modulate organic solar cell performance.

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Dr. Jessica Yajie Jiang
UNSW Sydney, Australia

Day 2: 11:45-12:00, Invited Talk

Title: Ultra-stable Near Unity Luminescent $CsPbBr_3$ Nanocrystals for Efficiency Enhancement in Commercial Silicon Photovoltaics.

Abstract: Robust surface passivation of $CsPbBr_3$ perovskite nanocrystals (PNCs) is essential for near-unity photoluminescence quantum yield (PLQY) and long-term stability, yet weakly bound ligands and persistent surface defects remain the principal bottlenecks for translating high-PLQY colloids into processable solid-state composites. Here, we show that in-situ formation of a strong Lewis base trioctylphosphine oxide (TOPO)–Zn complex via TOPO and $ZnBr_2$ co-passivation achieves strongly anchored surface binding, confirmed by ^{31}P diffusion-ordered NMR spectroscopy (DOSY) which identifies the ligands as surface-bound rather than free in solution. This anchored passivation suppresses trap-assisted non-radiative recombination, evidenced by a prolonged fast decay component (τ_1) rising from 7.2 ns in OA-capped PNCs to 16.6 ns in P-Zn PNCs, yielding near-unity PLQY. Because the complex converts a fragile colloid into a robust, composite-compatible building block, P-Zn $CsPbBr_3$ PNCs blended into multiple polymer matrices retain near-100% PLQY after three months of ambient storage, alongside improved thermal, photo, and water stability. Perovskite nanocrystals have been pursued as downshifting and downconversion materials for silicon photovoltaics for decades, yet a clear efficiency gain on a commercial-size, high-efficiency device has remained elusive. As a practical demonstration, we laminated P–Zn $CsPbBr_3$/ethylene-vinyl acetate (EVA) composite films onto commercial-size industrial silicon heterojunction (HJT) solar cells, among the most efficient silicon technologies available, producing a champion green-coloured device that simultaneously delivers a bright, vivid colour and a measurable power conversion efficiency boost. To our knowledge, this is the first demonstration of an obvious efficiency enhancement for perovskite nanocrystals on a commercial-size, highly efficient silicon cell, proving the real potential of this platform for durable, high-efficiency PV.



Biography: Dr Jessica Yajie Jiang is a Scientia Senior Research Fellow at UNSW Sydney, and UNSW Node Leader for Australian Centre for Advanced Photovoltaics (ACAP). Her research advances solar energy from improving the efficiency and reliability of silicon devices, to photon engineering that pushes efficiency beyond theoretical limits, perovskite stability and broader applications in buildings and vehicles. She partners with leading global manufacturers to translate research into commercial applications, and serves as Editor of IEEE Journal of Photovoltaics. She co-founded EnerJIN Pty Ltd, a solar IoT spin-out, and initiated the DFAT-funded ELICE Program, empowering the next generation of clean energy leaders.

Dr. Yumin Liu
Jingdezhen Ceramic University, China

Day 3: 12:00-12:15, Invited Talk

Title: Bimolecular Hetero-spatial Co-passivation Enables Efficient MA-free Wide-bandgap Perovskites for All-perovskite Tandem Solar Cells

Abstract: Perovskite solar cells (PSCs) have achieved certified power conversion efficiencies (PCEs) of 27%, approaching the Shockley–Queisser limit.1 All-perovskite tandem solar cells (AP-TSCs), which integrate a wide-bandgap (WBG) top cell with a narrow-bandgap bottom cell, provide a promising route toward efficiencies exceeding 30%.2 However, the performance of AP-TSCs is largely limited by WBG perovskites, which suffer from severe open-circuit voltage losses caused by surface and interface defects, light-induced phase segregation, and energy-level mismatch at the perovskite/electron transport layer interface.3 Gas quenching has emerged as a scalable and reproducible fabrication method for high-quality WBG perovskite films.4 Nevertheless, effective surface passivation remains essential for suppressing defect-assisted non-radiative recombination and optimizing interfacial energy-level alignment.5 Although low-dimensional perovskite passivation and various co-passivation strategies have significantly improved device performance,6 a single passivation molecule rarely achieves both efficient defect passivation and favorable energy-level alignment. Moreover, the influence of the spatial distribution of multiple passivators remains poorly understood. Herein, we implemented a bimolecular passivation strategy by achieving hetero-spatial distribution of piperazinium bromide (PipBr) and 3-(methylthio) propylamine hydrobromide (3MTPABr) in the WBG perovskite surface layer. Pip+ facilitates a reconstruction of the perovskite surface to form an anchored-gradient passivation region, while 3MTPA+ constructs an ultrathin low-dimensional perovskite capping layer atop this reconstructed region. This thumbtack-type spatial distribution of the two molecules effectively passivates surface defects and optimizes the energy-level alignment at the perovskite/C60 interface, achieving suppressed interfacial non-radiative recombination, enhanced charge transport, and improved surface hydrophobicity. Consequently, single-junction gas-quenched MA-free WBG (~1.76 eV) PSCs achieve a power conversion efficiency (PCE) of 20.80% (with a certified value of 20.02%) and retain 91.1% of their initial PCE after 600 h of operation under 1.0 sun illumination, demonstrating the importance of spatial molecular distribution in WBG perovskite co-passivation. Notably, the fabricated 2-terminal AP-TSC device attains a PCE of 28.34%, highlighting its considerable potential for AP-TSC applications.7

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Dr. Wei-Hsun Chiu
Queensland University of Technology, Australia

Day 2: 12:10-12:25, Oral Talk

Title: Origin of thermal induced variation in performance and negative reactance of inorganic CsPbI2Br perovskite solar cells

Abstract: Commercial viability of perovskite solar cells (PSCs) requires stable performance under daily temperature fluctuations. While previous research has extensively examined organic–inorganic hybrid PSCs at temperatures below 85 °C, understanding the charge carrier behaviour in PSCs at higher temperatures remains insufficiently characterised, a critical knowledge gap for deploying PSCs in extreme environments such as satellites. This study investigates charge-carrier and ion-transport mechanisms, and associated degradation processes, in all-inorganic mixed-halide CsPbI2Br PSCs with an inverted PIN architecture subjected to thermal cycling between 25 °C and 105 °C using in situ photoluminescence (PL) spectroscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), and in situ impedance spectroscopy (IS). Thermal cycling induces temperature-dependent halide migration and lattice expansion that not only transiently improve the carrier transport and device efficiency but also lead to structural degradation and the formation of non-photoactive secondary phases, defining a narrow window of stable operation. These ionic and structural changes account for inverted current– voltage hysteresis, progressive performance loss, and negative reactance in the impedance response under thermal stress. In situ optoelectronic and structural measurements link bandgap shifts, lattice parameter changes, and surface halide redistribution to these behaviours. A four-component extended matryoshka nested-ladder equivalent circuit separates the overlapping electro-ionic processes, relating thermally activated iodide and bromide migration and their activation energies to transport characteristics and impedance features. The results establish a mechanistic connection between ionic dynamics, lattice adaptation, and device performance, guiding halide-composition and lattice-stabilisation strategies to extend the stability of inorganic PSCs for high-temperature and extreme-environment applications.

Keywords: inorganic mixed halide perovskite, CsPbI2Br, thermal cycling, ion migration, impedance spectroscopy, in-situ characterization

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Room 2: Catalyst 7

Prof. Huai-Yong Zhu
Queensland University of Technology, Australia

Day 2: 10:50-11:10, Keynote Talk

Title: Harnessing Plasmonic Nanoparticle Antennas for Catalysis

Abstract: Plasmonic metal nanoparticles (NPs) offer a powerful strategy for harvesting low-intensity, continuous-wave visible light to promote catalytic reactions under mild conditions. Upon excitation of localised surface plasmon resonance, these NPs act as optical antennas, generating intense electromagnetic near fields and energetic hot electrons that can activate nearby homogeneous and heterogeneous catalytic sites via complementary mechanisms.[1-6] We have shown that the steep spatial gradients of plasmonic near fields can selectively bias the diffusion of highly polarizable molecules toward catalytic interfaces, where van der Waals and surface-specific interactions facilitate adsorption.[2-3] Consequently, molecular adsorption and desorption can be reversibly regulated by switching visible light on and off. This light-gated transport and adsorption enable high turnover frequencies even at very low reactant concentrations and provide a means to tune product selectivity using light, introducing a new approach to controlling chemical synthesis. Plasmonic near fields also markedly enhance the dehydration of sugars to 5-hydroxymethylfurfural (HMF) at moderate temperatures using visible-light-absorbing homogeneous Lewis acid catalysts4 and improve the activity of intermetallic catalytic sites for aerobic HMF oxidation to produce 2,5-furandicarboxylic acid. These results demonstrate that optical coupling between plasmonic antennas and nearby catalytic centres can substantially increase catalytic performance. In parallel, plasmon-generated hot electrons can be transferred to metal-cation catalytic sites through π-conjugated molecular mediators2 or injected directly into reactants to initiate reductive transformations.5 Near-field effects and hot-electron transfer can operate synergistically,2 while moderate thermal activation further increases the population of reactive energetic electrons, enabling activation of robust chemical bonds, including ammonia synthesis.[6] Together, these findings establish plasmonic metal NPs as versatile nanoscale antennas for controlling molecular transport, adsorption, charge transfer, reaction rates, and selectivity, providing a general framework for designing efficient light-driven catalytic systems.

Keywords: Plasmonic metal nanoparticles; optical antennas; plasmonic near field; hot-electrons; photocatalytic reactions

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Prof. Tianyi Ma
RMIT University, Australia

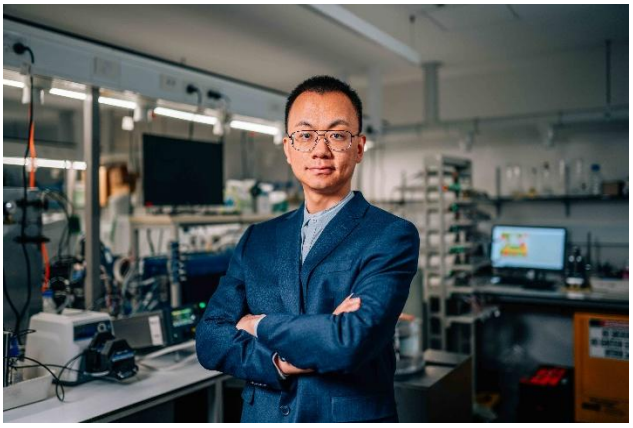
Day 3: 11:10-11:30, Keynote Talk

Title: Integrated CO2 Capture-Upgrading

Abstract: Carbon capture and utilization (CCU) technologies are critical to achieving net-zero emissions, yet conventional CO2 electroreduction requires energy-intensive desorption and purified CO2 feedstocks, limiting industrial adoption. We report a disruptive liquid-phase amine-captured CO2 electrolysis platform that directly converts CO2 from post-combustion flue gases into value-added C1 and C2 products without intermediate release, functioning as a plug-and-play module with existing amine scrubbing facilities. By co-optimizing catalyst architecture, interfacial engineering, and electrolyte composition, the system enables tunable selectivity toward CO, formate, and ethylene while maintaining tolerance to real-world flue gas impurities. Mechanistic insights from in situ spectroscopy and density functional theory reveal the key roles of catalyst-amine-CO2 interactions in driving high-efficiency conversion. Compared to conventional CCU routes, our approach achieves ~60% lower energy consumption and up to 70% lower capital costs, while eliminating the need for costly CO2 purification. Recent progress includes the development of metal-nitrogen-carbon frameworks and bimetallic interfaces optimized for continuous-flow operation, as well as pilot-scale demonstrations integrated with renewable electricity sources. This one-step capture–conversion process addresses critical bottlenecks in the CCU value chain, offering a scalable and economically compelling pathway for industrial carbon management.

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Tianyi Ma is a RMIT University Distinguished Professor, an Australian Research Council Future Fellow, Fellow of Royal Society of Chemistry, and Clarivate's Global Highly Cited Researcher. He is Director of ARC Industrial Transformation Hub for Intelligent Energy Efficiency in Future Protected Cropping (E2Crop), and Research Director of Centre for Atomaterials and Nanomanufacturing (CAN). His international standing is evidenced by >600 publications in top-tier journals with an H-index of 115 and >55,000 citations. His ground-breaking research has been acknowledged by internationally recognised experts and authorities via 2024 Prime Minister's Prize for Science - the Malcolm McIntosh Prize for Physical Scientist of the Year, AAS Le Févre Medal, Young Tall Poppy Science Award, ARC Discovery Early Career Researcher Award, and Horizon Prize of Royal Society of Chemistry. His scientific impact and leadership are also evidenced by supervision of over 40 Ph.D. students, secured more than AU$45m in government and industry funding, and heavy engagement in international academic roles, such as Associate Editor, Editorial Board Member and Guest Editor for over 15 international journals. He focuses on developing fundamental scientific breakthroughs and also up-scaling prototypes with far-reaching industry influence and real-life applications. Demonstrations and pilot plants have been established locally in Australia to drive his technologies to practical deployment and commercialisation, for example, the square meter sized solar-to-hydrogen generator, kilowatt level CO2

electrolyser, kilogram-sale formic acid production micro-pilot plant, and high-energy density battery packs, which may change the way how society generates and consumes energy and chemicals.

Prof. Torben Daeneke
RMIT University, Australia

Day 3: 11:30-11:50, Keynote Talk

Title: Liquid Metal Alloys as Next-Generation Catalysts for Clean Chemical Production

Abstract: Liquid metal alloys are emerging as a powerful and unconventional platform for heterogeneous catalysis. Their fluid nature enables self-renewing catalytic interfaces, resistance to deactivation, and reactivity that can be precisely tuned through compositional design - properties that solid catalysts struggle to match. This talk presents work from the Liquid Metal Research Group at RMIT University on the application of gallium-based liquid metal alloys to a suite of reactions relevant to clean energy and sustainable chemical production. Across transformations including ammonia synthesis, CO_2 conversion, alkane dehydrogenation, and more, liquid metal alloys offer a compelling alternative to conventional catalytic materials. The ability to dissolve and dynamically redistribute catalytically active elements within a liquid matrix unlocks synergistic effects between metals that are individually poor catalysts - a principle demonstrated recently in Nature Catalysis for ammonia synthesis. Reaction design and scalability are also discussed. This body of work illustrates the broad potential of liquid metals to underpin a new generation of energy-efficient, low-emission chemical processes.

Keywords: Liquid Metal, Catalysis, CO2 conversion

Dr. Wenxian Li
University of New South Wales, Australia

Day 3, 11:50-12:05, Invited Talk

Title: Minimizing Energy Loss in Electrocatalysts for Water Splitting

Abstract: Catalysts play a crucial role in water electrolysis by reducing the energy barriers for hydrogen and oxygen evolution reactions (HER and OER). However, the energy consumption of catalysts has often been overlooked due to the intricate interplay among catalyst microstructure, dimensionality, catalyst–electrolyte–gas dynamics, surface chemistry, electron transport within electrodes, and electron transfer among electrode components. Efficient catalyst development for high-current-density applications is essential to meet the increasing demand for green hydrogen. This involves transforming catalysts with high intrinsic activities into electrodes capable of sustaining high current densities. We discussed the current improvement strategies of mass exchange, charge transfer, and reducing electrode resistance to decrease energy consumption. First, we elucidate the strategy to decrease the energy consumption of catalysts with hierarchical structure in water electrolysis. Next, the hierarchical porous structure design is reviewed to explicate the influence of micropores, mesopores, macropores, and hierarchical pores on mass exchange in water electrolysis. Then, the charge transfer between nanoparticles is highlighted to link nanoparticles with chemical bonds rather than physical contacts in the binders. We also review the application of conductive current collectors, such as nickel foam (NF), to increase the current density in the electrodes for the practical application of hierarchical catalysts. At last, we highlight the challenges faced by hierarchical catalyst design in theory and experiments due to the choice and assembly of functional units, characterisation of the microenvironments in the confined space of the porous structure, and prediction of the stability of catalysts in harsh environments. The contents reveal that affordable green hydrogen production depends on the low-energy-consumption electrode design under the premise of a low renewable electricity price.

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Dr. Wenxian Li is an ARC Future Fellow at UNSW Sydney, recognised for his pioneering work in materials chemistry and sustainable energy technologies. His research focuses on chemical recycling and upcycling of waste plastics, catalytic reaction kinetics in confined environments, and advanced nanocomposites for energy applications. He develops catalytic systems for chemical recycling and upcycling of plastics, aiming to close the loop on polymer waste. His work explores reaction kinetics in micro- and nano-environments to enhance catalytic efficiency. Additionally, he designs functional-unit-based hierarchical nanocomposites for energy storage and conversion, including hydrogen generation and advanced batteries. His interdisciplinary approach

integrates materials chemistry, nanotechnology, and green engineering to address global challenges in energy sustainability and environmental protection.

Dr. Jinqiang Zhang
University of Technology Sydney, Australia

Day 3, 12:05–12:20, Invited Talk

Title: Refining structures of electrochemical catalysts for energy storage and conversion

Abstract: The development of highly efficient catalysts to improve electrochemical performance is urgently needed due to the ever-increasing demand for energy storage and conversion devices in the last few decades. However, the electrochemical performances are still not satisfying to be potentially used in industrial applications. Here, we present our recent research on the structure tuning for electrocatalysts designed for energy storage and conversion devices such as Li-O2 batteries and electrochemical water splitting.1-5 We show that by carefully designing and tailoring the molecular and electronic structures, the efficiency of the applied catalysts could be maximized which would be highly beneficial for the electrochemical performances in their individual applications. For instance, TEMPO-modified ionic liquid could stabilize the lithium anode and prolong the cycle life of Li-O2 battery,2 while in-situ exfoliated MXene coupled with single Pt atoms show a mass activity more than 40 times higher than the commercial Pt/C.4 All these provide theoretical and experimental guidance to develop highly efficient catalysts for energy storage and conversion devices in the future.
Keywords: Electrocatalysts, refining structure, organic structure, atomic structure, energy storage and conversion,

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Jinqiang Zhang obtained his PhD degree from the University of Technology Sydney in 2018. He has worked as a Postdoctoral Research Associate in the Centre for Clean Energy Technology at the University of Technology Sydney from 2018 to 2021, and a Postdoc Research Fellow at the University of Toronto from 2021 to 2023. He is currently a Chancellor's Research Fellow and DECRA Fellow at the University of Technology Sydney. His work mainly focuses on the design and synthesis of functional organic molecules and single-atom catalysts in energy conversion and storage systems such as hydrogen evolution reactions, oxygen evolution reactions, oxygen reduction reactions, CO_2 reactive capture, lithium-ion batteries, lithium–sulfur batteries, and lithium–air batteries.

Bharathi Mohan V
RMIT University, Melbourne, Australia

Day 3, 12:20-12:32, Oral Talk

Title: CoSeTe as an asymmetric bridging co-catalyst for photocatalytic hydrogen generation over modified g-C3N4

Abstract: Global energy demand necessitates a transition from conventional fossil fuels to renewable resources. Among them, solar energy is the most promising, as it is abundant and continuously replenished. A sustainable method for harnessing solar energy to produce green hydrogen is photocatalysis, which relies solely on water and sunlight. However, practical application is constrained by intrinsic drawbacks of photocatalysts, including rapid charge recombination, poor light absorption, photocorrosion, and low solar-to-hydrogen efficiency. To overcome these challenges, we employed a visible-light-active photocatalyst, capitalizing the fact that nearly 45% of the solar spectrum lies within the visible region. Graphitic carbon nitride (g-C3N4), a two-dimensional layered semiconductor, was selected as the base material. To address its inherent limitations, g-C3N4 (2.75 eV) was modified into a porous structure and introduced localized states (S 2p) between its conduction and valence bands, thereby shortening diffusion lengths, enhancing reactant adsorption, and extending light absorption region. This yields a hydrogen evolution rate of ~0.9 mmol/h/gcat. To further amplify activity, an asymmetric bridging site co-catalyst, CoSeTe, was incorporated. Systematic optimization reveals that 10 wt.% CoSeTe on modified g-C3N4 achieved a remarkable hydrogen production rate of ~12 mmol/h/gcat with excellent stability over five days. The asymmetric bridging sites provide dual active centers, in which Se–H and Te–H intermediates exhibit distinct bond energies, thereby facilitating balanced hydrogen adsorption/desorption and accelerating surface reaction kinetics. To predict the electron transfer pathway, Ultraviolet photoelectron spectroscopy was recorded, confirming that the work function (ϕ) of CoSeTe exceeds that of modified g-C3N4, inducing upward band bending at the interface. This establishes a Schottky junction, which significantly enhances charge separation, facilitates electron transfer, and suppresses electron backflow. The detailed synthesis, structural/electronic characterization, and mechanistic insights into charge transfer dynamics will be presented, offering a pathway toward rational photocatalyst design for efficient and stable solar hydrogen production.
Keywords: Photocatalyst, g-C3N4, CoSeTe, Cocatalyst, Hydrogen production

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Room 3: Optoelectronic 3

Assoc. Prof. Jingwei Hou
The University of Queensland, Australia

Day 3, 10:50-11:10, Keynote Talk

Title: Metal–Organic Framework Glasses: A Versatile Platform for Next-Generation Optoelectronic and Energy Materials

Abstract: Glasses formed from metal–organic frameworks (MOFs) have emerged as the first new category of glass-forming materials in decades, combining the processability of conventional glasses with the chemical versatility of hybrid framework solids. Melt-quenched zeolitic imidazolate framework (ZIF) glasses retain the metal–ligand connectivity of their crystalline parents while providing grain-boundary-free, transparent and mechanically compliant matrices. This talk will outline our efforts to develop MOF glasses into a functional materials platform for next-generation optoelectronic and energy applications. First, I will discuss MOF crystal–glass composites, in which functional crystalline frameworks are dispersed within a ZIF glass matrix to impart properties inaccessible to either component alone [1]. Second, I will present the liquid-phase sintering of halide perovskites with MOF glasses, where the glass flows around and interfaces with perovskite grains at modest temperatures. The resulting composites stabilise the optically active black phase of CsPbI3 against moisture, heat and continuous illumination while preserving strong photoluminescence, establishing MOF glasses as protective and processable hosts for otherwise fragile optoelectronic semiconductors [2]. I will then show how this glass-stabilisation strategy extends to luminescent emitters for scintillation and X-ray detection, and how halide chemistry can be used to tune the structure, melting behaviour and optical properties of the glasses themselves [3]. Finally, I will discuss emerging opportunities for MOF glasses in solid-state ionic transport and membrane-based molecular separations, together with the outstanding challenges in scalable processing, interfacial engineering and long-term stability that must be addressed to translate hybrid glasses into practical devices.

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Dr Jingwei Hou is an Associate Professor in the School of Chemical Engineering at The University of Queensland, where he directs the UQ Nanomaterials Centre. His research focuses on hybrid glasses, metal–organic framework (MOF) glasses and their composites, spanning glass chemistry, membrane-based separations, and optoelectronic and energy materials. His group pioneered MOF crystal–glass composites and the liquid-phase sintering of halide perovskites within MOF glasses, opening new routes to stable and processable functional materials. His work has been published in journals including Science, Nature Communications and the Journal of the American Chemical Society.

Dr. Haoran Ren
Monash University, Australia

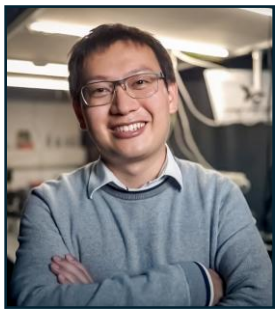
Day 3, 11:10-11:30, Keynote Talk

Title: Lightwave valleytronics based on a meta-waveguide optoelectronic chip

Abstract: The valley degree of freedom has emerged as a transformative platform for ultralow-power information processing and quantum computing. Transition metal dichalcogenides (TMDCs) are prime candidates for lightwave valleytronics, offering optical control over valley polarisation at an ultrafast speed. Despite progress in the generation, free-space steering, and on-chip waveguide routing of valley-dependent chiral photons, previous nanophotonic platforms are not fully integrated, relying on bulky and inefficient far-field optical detection of valley information. I will present an ultracompact hybrid optoelectronic nanocircuit leveraging TMDCs for all-on-chip generation, selective routing, and electrical readout of valley-dependent chiral photon emissions [1]. This demonstration bridges a critical gap in lightwave valleytronics, paving the way for compact and scalable valleytronic information processing in both classical and quantum regimes.

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Dr Haoran Ren is an ARC Future Fellow and Senior Lecturer in the School of Physics and Astronomy at Monash University, where he leads the Monash NanoMeta Group. His research explores the multidimensional nature of light and engineered light–matter interactions at the nanoscale and quantum level. He currently serves as Secretary of the Australian and New Zealand Optical Society. His honours include the 2024 SPIE Best Paper Award, the 2023 Rising Stars of Light, and the 2022 ANZOS Geoff Opat Early Career Researcher Prize. He has also held an ARC DECRA Fellowship, a Macquarie University Research Fellowship, a Humboldt Fellowship, and a Victoria Fellowship.

Dr. Xueqian (Queenie) Sun
Australian National University, Australia

Day 3, 11:30-11:45, Invited Talk

Title: Optical Visualization of Carrier Surfing in 2D Monolayers Driven by Surface Acoustic Waves

Abstract: Charge carrier transport is pivotal in advancing nanoelectronics. Despite progress in exciton transport within ultra-thin semiconductors, the intertwined transport of free carriers and excitons presents challenges. Surface Acoustic Waves (SAWs) offer a compelling solution, enabling remote, real-time control of excitonic states at room temperature via surfing carriers in 2D materials—a relatively unexplored domain. SAWs create a versatile platform for tailoring excitonic states from microwave to optical frequencies. This study first demonstrates a simple route to visualize directional light transport and carriers drift driven by non-perfect Rayleigh-SAWs. Carrier surfing is observed under SAW modulation, with a charge redistribution rate of ≈16.4 μm s−1, significantly exceeding their natural redistribution in monolayers without SAW, while the drift velocity of free electrons remains on the order of ≈103 m s−1. Enhanced exciton emission is achieved through standing SAWs, generating periodic oscillations. By combining traveling and standing wave portions, controllable on-demand single-chip emission is feasible. The findings open avenues for light manipulation, photonic circuits, and on-chip communications technologies.

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Dr Xueqian Sun is a Research Fellow and ARC DECRA Fellow in the School of Engineering at the Australian National University. She received her B.E. with First Class Honours and Ph.D. in Engineering from ANU in 2017 and 2024, respectively, with her doctoral thesis shortlisted as a finalist for the J G Crawford Prize. Her research focuses on engineering excitonic states and light–matter interactions in atomically thin semiconductors and van der Waals heterostructures. She develops optical spectroscopy and nanodevice platforms to control light emission, light transport and many-body interactions for low-power optoelectronics, quantum light emission and sensing technologies.

Prof. Waner He

China Normal University, China

Day 3, 11:45-12:00, Invited Talk

Title: Charge-Trapping Materials Engineering for Solution-Processed Organic Synaptic Transistor Memories

Abstract: Organic field-effect transistor memories provide an attractive platform for flexible, low-cost, and neuromorphic electronics. Their memory characteristics, however, strongly depend on the chemical nature, spatial distribution, and stability of charge-trapping sites. Here, we present two complementary materials-engineering strategies for controlling charge trapping in solution-processed organic transistor memories. In the first approach, dimethyl 2-pyrone-4,6-dicarboxylate (PDC-DE), a biomass-derived compound obtained from a lignin degradation product, was incorporated into the p-type semiconducting polymer PDPP4T. The addition of 15 wt% PDC-DE introduced accessible charge-trapping sites, enhanced threshold-voltage modulation, and promoted a progressively enlarged memory window during repeated programming and erasing. This behavior indicates field-activated charge trapping rather than rapid trap saturation. The resulting devices also exhibited paired-pulse facilitation and pulse-number-dependent long-term potentiation. In the second approach, a crosslinked donor–acceptor polymer electret was fabricated through a [2+2] cycloaddition–retroelectrocyclization reaction between an electron-rich alkyne polymer and a TCNQ-containing polyester. The crosslinked electret showed sufficient solvent resistance to enable the subsequent solution deposition of both p-type PBTTT-C14 and n-type N2200 semiconductors. The devices displayed large memory windows, retention times exceeding 104 s, ON/OFF current ratios above 103, and stable endurance over 100 cycles. Short- and long-term memory, synaptic plasticity, and multilevel information storage were further demonstrated. These results show that molecular-scale regulation of charge-trapping media, ranging from sustainable molecular additives to crosslinked polymer electrets, provides a versatile route toward reliable and solution-processable organic memory and neuromorphic devices.

Keywords: Organic transistor memory; charge trapping; polymer electret; biomass additive; artificial synapse

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Dr. Wenxin Mao
Monash University, Australia

Day 3, 12:00-12:15, Invited Talk

Title: Photo-modulation of Ion Distribution in Metal Halide Perovskites

Abstract: Metal halide perovskites (MHPs) have emerged as leading semiconductors for the next generation of solar cells, light-emitting devices, and photodetectors. A critical requirement for many optoelectronic applications is the ability to tune the semiconductor bandgap. In MHPs, this is achieved by controlling the halide ratio, resulting in composition-dependent mixed-halide perovskite species. However, bandgap instability—driven by light-induced phase segregation—presents a major challenge for their future commercialization. This talk will present our recent findings on the microscopic mechanisms of how photoexcitation impacts the distribution of halide species within single-crystalline mixed-halide perovskite microplatelets. Key topics include:

- Insight into Segregation Domains: Utilizing a combination of widefield narrowband fluorescence imaging and time-resolved fluorescence spectroscopy to uncover the nature of light-induced halide segregation domains. [1]
- Reversibility and Bandgap Control: Demonstrating that photoinduced halide segregation can be completely reversed at sufficiently high illumination intensities. This enables precise control over the optical bandgap of a mixed-halide perovskite single crystal by optimizing the photogenerated carrier density. [2]

Mechanisms in 2D Perovskites: A detailed discussion on light-induced distributions in layered 2D perovskite materials. Through hyperspectral imaging, in situ X-ray diffraction, and first-principles calculations, we uncover a mechanism of structurally encoded, site-selective photoisomerization rather than halide segregation. This discovery offers a new strategy for reconfigurable optoelectronic devices, non-volatile optical memory, and quantum photonics. [3]

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Dr. Wenxin Mao is a Senior Lecturer and Director of International Education within the Department of Chemical and Biological Engineering at Monash University. He earned his PhD from Monash University in 2019. Prior to his current appointment, Dr. Mao was a Royal Society Newton International Fellow and Senior Research Associate in the Department of Chemical Engineering and Biotechnology at the University of Cambridge. His distinguished research background also includes an Australian Centre for Advanced Photovoltaics (ACAP) Fellowship and a tenure as a Research Fellow with the ARC Centre of Excellence in Exciton Science at Monash University

Room 4: Theoretical Computation & Machine Learning 3

Assoc. Prof. Chun Ouyang
Queensland University of Technology, Australia

Day 3, 10:50-11:10, Keynote Talk

Title: Deep Time-Series Models Meet Electricity Price Volatility

Abstract: As the global energy grid undergoes rapid transformation, electricity markets are becoming increasingly volatile. Price spikes and crashes are now routine, imposing substantial financial risks, yet conventional forecasting methods consistently underestimate these extremes. Even advanced AI and deep learning models fall short by treating spikes and crashes symmetrically, despite their distinct physical and market drivers [1]. Existing approaches also characterize distributions instead of price levels [2], estimate occurrence rather than magnitude [3], or rely on rigid regime boundaries that amplify forecasting errors [1, 4]. In this keynote, we will bridge the gap between cutting-edge AI and the volatility reality of modern electricity markets. We begin with a comprehensive evaluation of state-of-the-art deep learning models across all five regions of the Australian National Electricity Market. The results reveal a striking reality: under extreme electricity prices, benchmarked deep time-series models systematically break down [6]. To solve this, we introduce the Gated Tail-Residual Network (GTR-Net), a novel deep learning architecture designed specifically for extreme market environments. Rather than forcing a single algorithm to capture both everyday trends and sudden market shocks, GTR-Net functions like a process plant with separate control pathways for normal operation and process upsets, allowing each to be handled by the mechanism best suited to its operating regime. It features:

- Decoupled Dynamics: It separates the modeling of "normal" baseline market behavior from extreme "tail" events.
- Asymmetric Pathways: It uses dedicated, independent channels to model price spikes versus price crashes, recognizing that the physical drivers behind each are fundamentally different.
- Smart Gating Mechanisms: It acts as an active filter, cleanly injecting extreme-event corrections into standard forecasts exactly when needed, without disrupting normal day-to-day predictions.

Using real-world Australian market data, we demonstrate how GTR-Net can be integrated with existing forecasting models to significantly improve accuracy during market volatility. This work reveals the structural limitations of conventional forecasting, validates asymmetric tail modeling, and shows how gated deep learning architecture enables robust extreme-value prediction in highly stochastic energy grids.

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A/Prof Chun Ouyang is a leading researcher in process mining and a pioneer in explainable data analytics, developing innovative machine learning methods to advance process intelligence and AI-driven energy analytics. As leader of the Explainable Analytics for Machine Intelligence (XAMI) Lab at Queensland University of Technology, she contributes to the development of trustworthy, transparent, and fair AI systems. She has secured over $8 million in competitive research funding, published more than 100 peer-reviewed papers, and has a Google Scholar H-index of 39. As the Academic Lead of the School's Higher Degree Research portfolio, she provides strategic leadership in research training and supervision, while mentoring higher degree research candidates and early career researchers.

Dr. Tu Le
RMIT University, Australia

Day 3, 11:10-11:30, Keynote Talk

Title: Energy Materials Development using Machine Learning

Abstract: The design and synthesis of materials with useful, novel properties is one of the most active areas of contemporary science, generating a veritable explosion of scientific activity in areas such as biomaterials, cell and tissue engineering, organic photovoltaics and light-emitting materials, and nanomaterials for a myriad of medical and nonmedical applications. This new era of materials design and discovery covers many disciplines from chemistry and biology to physics and engineering. Conventionally, it takes at least 20 years to move a material from initial discovery to the marketplace. To accelerate the pace of novel materials discovery, computational methods such as artificial intelligent machine learning techniques can be used to construct predictive materials property models and allow rapid scanning of large chemical datasets to systematically identify attractive candidates for specific applications. This presentation will showcase recent studies on data-driven design of functional materials for energy applications.

Dr. Aoni Xu
The University of Sydney, Australia

Day 3, 11:30-11:45, Invited Talk

Title: The Dynamic Electrochemical Interface in CO_2 Reduction

Abstract: Computational studies of CO_2 electroreduction commonly evaluate reaction energetics on idealised electrode surfaces. Under operating conditions, however, the interfacial composition can deviate substantially from the bulk electrolyte, and the resulting local chemical environment can determine reaction kinetics and product selectivity. Here, we combine first-principles calculations and multiscale modelling to elucidate how mass transport, adsorbate coverage and interfacial structure govern CO_2 electroreduction. On copper, we show that local CO_2 depletion changes the kinetic competition among carbon-reduction pathways and hydrogen evolution, thereby redirecting selectivity towards methane. We further demonstrate that surface hydrogen coverage is an active component of the reaction network: adsorbed hydrogen can either form H_2 or participate in the hydrogenation of carbon-containing intermediates, thereby influencing multicarbon alcohol formation. We also show that interfacial chemistry can be engineered through cooperative catalyst architectures. Atomistic modelling of copper–alkaline-earth-metal-oxide interfaces reveals that chemically distinct sites regulate hydrogen transfer and selectively stabilise alcohol-forming intermediates. In molecular CO_2-reduction systems, secondary coordination environments similarly control intermediate stabilisation and transfer during tandem reaction sequences. Finally, we integrate potential-dependent phase diagrams, machine-learning interatomic potentials and molecular dynamics to predict surface reconstruction and adsorbate-stabilised structures under electrochemical conditions. These results establish that CO_2 electroreduction is governed by the coupled evolution of local reactant concentration, adsorbate population and interfacial structure, rather than by electrode composition alone.

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Biography: Dr Aoni Xu is a Lecturer and Sydney Horizon Fellow in the School of Chemical and Biomolecular Engineering at The University of Sydney. As an electrochemistry and computational modelling researcher, her work integrates Density Functional Theory (DFT) and AI to design high-performance materials and study electrocatalyst stability, with a strong focus on green ammonia electrosynthesis and CO_2 reduction. Before establishing her independent research career in Australia in 2024, Dr Xu completed a Postdoctoral Fellowship at the Technical University of Denmark under Prof. Jens K. Nørskov, and held visiting scholar appointments at the University of Toronto and UC Berkeley. She earned her PhD from the University of Science and Technology, Beijing. Dr Xu has published over 70 papers in premier journals, including Nature and Science, amassing more than 7,100 citations and an H-index of 31. Her research contributions have been recognised through Stanford's Top 2% Most Highly Cited Scientists, the Faculty of Engineering Dean's Award for Emerging Research Excellence at the University of Sydney and the Rising Star Award from the Women of Colour in STEM Awards. She also serves as a member of the Early Career Advisory Board of JACS Au.

Dr. Xin Mao
Queensland University of Technology, Australia

Day 3, 11:45-12:00, Invited Talk

Title: Ligand Engineering in MIL-53(Cu) Nanozymes for Selective Electrochemical CO2 Reduction to C2 Products by Molecular Modelling

Abstract: Electrochemical CO_2 reduction provides a promising route for converting CO_2 into value-added chemicals using renewable electricity; however, the selective production of C_2 products remains challenging due to the stringent requirements for efficient C–C coupling. In this work, density functional theory (DFT) calculations were performed to investigate a series of ligand-engineered MIL-53(Cu) nanozymes as artificial enzyme catalysts for CO_2 reduction. By introducing electron-donating and electron-withdrawing functional groups into the organic ligands, the Cu–Cu distance and electronic structure of the catalytic sites can be systematically tuned, thereby regulating the adsorption of key reaction intermediates and the catalytic performance. Among the investigated catalysts, COOH-functionalized MIL-53(Cu) exhibits the optimal geometric and electronic configuration, delivering the highest predicted activity and selectivity toward ethanol production with a limiting potential of only 0.47 V. The computational predictions were further validated experimentally, where COOH-functionalized MIL-53(Cu) achieved a Faradaic efficiency of 55.5% for C_2 products at −1.19 V versus the reversible hydrogen electrode, significantly outperforming the benchmark Cu electrode. These findings demonstrate that ligand engineering is an effective strategy for optimizing Cu active sites and provide valuable insights into the rational design of artificial nanozymes for highly efficient and selective CO_2 electroreduction.

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X. Mao, W. B. Gong, and A. J. Du, *J. Am. Chem. Soc.***2023**,145, 21442−21453



Biography: Dr. Xin Mao is DECRA Fellow and Lecturer in the School of Chemistry and Physics at Queensland University of Technology (QUT), Australia. He received his Ph.D. from the School of Chemistry and Physics at QUT in 2022 and subsequently continued his postdoctoral research in the group of Professor Aijun Du. In 2024, he joined the group of Professor Yan Jiao at the University of Adelaide as an ARC-funded Research Fellow. He later returned to QUT as a Lecturer. His research focuses on computational electrocatalysis, with particular interests in developing and applying molecular dynamics simulations and constant-potential methods to investigate electrocatalytic reactions involving small molecules.

Md Tarikal Nasir
Queensland University of Technology, Australia

Day 3: 12:00-12:12, Oral Talk

Title: Computational Design of Electrocatalysts for Energy and Environmental Applications

Abstract: Ammonia (NH3) and urea (NH2CONH2) are essential industrial chemicals [1, 2], whose production depends on the Haber-Bosch and Bosch-Meiser processes, respectively. Together, these two processes consume 2% of global energy with substantial CO2 emissions. The electrocatalytic nitrate/nitric oxide reduction to ammonia (NO3RR/NORR) and urea synthesis, powered by renewable energy, offers an alternative to fossil fuel-based methods. However, the sluggish kinetics from a complex electron transfer process, coactivation and conversion of different bonds, byproduct formation, hydrogen evolution reaction (HER), and two-step C-N coupling result in low yield rate and Faradaic efficiency [3-4]. Thus, strategies including doping, anchoring atoms, vacancy engineering and polarization switching enhance the catalytic activity and selectivity [5]. Furthermore, the edge sites of a catalyst are more active than atoms on the other parts of the surface [6]. Based on density functional theory (DFT), we studied NORR on defective α–In_2Se_3 with a single selenium vacancy (VSe–In_2Se_3), NO3RR on the edge of InSe nanoribbons, and urea synthesis on Cu and p-block atoms (B, Al, Ga, In) anchored on N-doped graphene (N6G). The electronic structure analysis describes the origin of high catalytic activity. A remarkably low limiting potential (UL) of -0.10 V, highlighting edge-driven InSe nanoribbons as a promising catalyst for NO3RR. VSe–In_2Se_3↓ achieves a notably lower value (UL = -0.48 V) compared to VSe–In_2Se_3↑ (UL = -0.82 V). In addition, CuAl@N6-G and CuIn@N6-G catalysts exhibit exceptional performance for urea production. Moreover, the formation of the byproducts and the competing HER is suppressed for all these catalysts. Thus, our work offers catalyst candidates for NOxRR and the electrosynthesis of urea, which could potentially be utilized for a wide range of electrochemical applications.

Keywords: Polarization switching, vacancy engineering, edge-driving, anchoring atoms.

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Fozia Batool
Australian National University, Australia

Day 3: 12:12-12:24, Oral Talk

Title: Understanding Properties of SAF/Jet Fuel Blends: DFT and MD Studies

Abstract: Understanding the thermophysical properties of sustainable aviation fuel (SAF) blends in conventional jet fuels is essential for the rational design and optimisation of next-generation aviation fuel formulations. This study combines density functional theory (DFT) and all-atom molecular dynamics (MD) simulations to investigate the composition-dependent properties of SAF/jet fuel blends, with JP-10 as the representative high-energy-density SAF component. DFT calculations were performed to characterise the molecular geometry and electronic properties of JP-10 and the blend components, providing the molecular-level foundation for the MD parameterisation. A six-component jet fuel surrogate was used as the baseline, with JP-10 introduced at varying mole fractions. The molecular systems were parameterised using the appropriate force field in the MD simulations. Following energy minimisation and thermal equilibration under NVT and NPT ensembles, 4 ns production simulations were performed at 298 K and atmospheric pressure. The simulations reveal a clear composition-dependent increase in equilibrium density across the blend series, increasing from 0.7948 g cm^{-3} for the baseline surrogate to 0.9221 g cm^{-3} for pure JP-10, with intermediate blends exhibiting a consistent progressive trend. Energetic profiles stabilised after equilibration, confirming the reliability of the simulated liquid states. These results demonstrate that the integrated DFT–MD framework effectively captures systematic composition–property relationships in complex SAF/jet fuel blends and supports computational screening of fuel formulations prior to experimental evaluation.

Keywords: Sustainable aviation fuel; JP-10; Aviation fuel surrogate; Molecular dynamics; Thermophysical properties

Room 5, Low Energy Devices 4

Prof. Zhenxiang Cheng
University of Wollongong, Australia

Day 3: 10:50-11:10, Keynote Talk

Title: Novel type of Multiferroics, Magnetoelectric Coupling and their Energy-related applications

Abstract: Multiferroic materials, which uniquely combine ferroelectric polarization and magnetic order, exhibit remarkable cross-coupling phenomena. This enables magnetoelectric coupling, where electric fields can regulate magnetism and vice versa. These extraordinary properties position them as highly promising candidates for advanced applications in sensors, computing, and energy technologies. However, their development encounters significant challenges due to the conflicting electronic requirements of transition metals (e.g., the need for partially filled 3d orbitals), making such materials exceedingly rare. Traditional Type-I multiferroics possess independent ferroelectric and magnetic orders, resulting in weak magnetoelectric coupling. In contrast, Type-II multiferroics derive their ferroelectric polarization directly from magnetic ordering, though they typically suffer from low polarization values and are often constrained to cryogenic temperatures, thereby limiting practical applications. Recently, the discovery of altermagnetism—a novel magnetic phase characterized by zero net magnetization alongside strong spin-splitting—has opened up exciting opportunities for next-generation information processing and sensor technologies. By coupling ferroelectricity with altermagnetism, we propose an innovative class of materials: Type-III multiferroics, in which ferroelectric polarization directly modulates spin-splitting. Moreover, advancements in nano multiferroics highlight unique intrinsic advantages, including strong built-in electric fields, robust magnetic moments, and efficient mechano-electrical conversion. These characteristics make multiferroic nanomaterials exceptional candidates for applications such as transducers, actuators, and energy storage and conversion devices. During this talk, I will also share our latest innovations and experimental demonstrations, showcasing the potential of these remarkable materials in the fields of water splitting and energy storage.

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Biography: Zhenxiang Cheng earned his Bachelor of Science in Physics and Ph.D. in Materials Science from Shandong University, China. Recognized for his exceptional research potential, he was awarded the prestigious JSPS Fellowship, enabling him to pursue advanced research at Japan's National Institute for Materials Science (NIMS). Later, he joined the University of Wollongong (UOW) as a Research Fellow, where he secured an Australian Research Council (ARC) Future Fellowship for his groundbreaking contributions to multiferroic materials and physics. Currently serving as a Professor at UOW, he leads the Multiferroic Materials Research theme. His research focuses on ferroic systems—including magnetic, ferroelectric, and multiferroic materials—with a strong emphasis on design fo the novel ferroic materials and understanding their fundamental physics and advancing their applications in diverse fields such as information stroge and energy-related technologies.

Assoc. Prof. Ming Li
The University of New South Wales, Australia

Day 3: 11:10-11:30, Keynote Talk

Title: Microfluidic Technologies for Microbial Cell Analysis in Renewable Energy Applications

Abstract: Microbial cells are emerging as a promising next-generation source of renewable energy through sustainable biofuel production. Significant advances have been made in harnessing bacteria, yeast, and microalgae to generate biofuels; however, identifying, engineering, and selecting high-performing microbial strains remains a major challenge. Advanced analytical tools capable of rapidly screening and characterising individual microbial cells have the potential to accelerate strain engineering, selection, and optimisation for sustainable energy applications. In this talk, I will introduce my group's efforts to develop microfluidic technologies [1-3] for high-throughput microbial cell screening and selection. By enabling precise analysis, sorting, and isolation of individual microorganisms, our microfluidic platforms facilitate the identification of superior microbial strains with enhanced functional performance. These technologies provide powerful tools to accelerate the development of next-generation biofuel technologies and advance broader sustainable biotechnology applications.

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Dr. Ying Liu
The University of Sydney, NSW 2006, Australia and Catalan Institute of Nanoscience and Nanotechnology (ICN2), Campus Universitat Autonoma de Barcelona, Spain

Day 3: 11:30-11:50, Keynote Talk

Title: Topological domain walls in archetypal antiferroelectric PbZrO3

Abstract: Antiferroelectric materials have attracted considerable attention for high-power energy-storage applications owing to their reversible electric-field-induced phase transition and high energy-storage efficiency. They feature antiparallel electric dipoles generated by the spatial separation of positive and negative charge centres. PbZrO3, long regarded as the archetype of antipolar order, is now known to host unexpectedly rich polar and topological phenomena at the nanoscale. We show that nominally antipolar PbZrO3 contains ferrielectric (↓↑↓) dipolar units embedded as translational boundaries, forming polar stripes consistent with the theoretically predicted ground state structure of PbZrO3. These ferrielectric boundaries exhibit continuously tunable polarization that can reverse sign without switching atomic displacement direction, indicating a soft polar energy landscape and providing a microstructural origin for the remanent polarization observed in many antiferroelectrics.1 Additionally, nanoscale vortices-like domains and antivortices were observed at twin boundaries in PbZrO3. Such topological domains are well known in ferroelectrics, where they emerge to minimize depolarization fields. In contrast, they were not expected to appear in antiferroelectrics due to their antiparallel dipole alignment. In-situ electron-beam-driven domain-wall motion revealed dynamic switching between charged and neutral configurations, accompanied by the appearance and annihilation of antivortices. These findings establish antiferroelectrics as a new platform for exploring topological dipole textures, extending the frontier of topological matter beyond ferroelectrics and suggesting novel avenues for functional device design.2

Keywords: Antiferroelectrics; Lead Zirconate (PbZrO3); Transmission Electron Microscopy; Energy Storage

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Dr Ying Liu is a materials scientist specialising in ferroic materials and advanced electron microscopy. She received her PhD in Materials Science and Engineering from the Institute of Metal Research, Chinese Academy of Sciences, in 2017. She subsequently worked at the University of Sydney and as a co-funded Marie Curie fellow at Catalan Institute of Nanoscience and Nanotechnology in Barcelona. Her research focuses on uncovering atomic-scale mechanisms governing the structure and properties of ferroelectric, and antiferroelectric materials. She has particular expertise in aberration-corrected (scanning) transmission electron microscopy and in-situ electrical biasing, heating, and mechanical straining techniques.

Dr. Mengyao Li
University of New South Wales, Australia

Day 3: 11:50-12:05, Invited Talk

Title: Bridging Moisture-Electric Generation and Hydrogen Evolution through Neutral Hydrogen Intermediates

Abstract: Ambient moisture is an abundant but underutilized renewable energy source for next-generation energy devices. Although moisture-electric generators (MEGs) can convert humidity gradients into electricity, their energy utilization remains limited because ion-electron recombination is usually treated as a loss pathway. Here, we present a carrier-type-engineered graphene oxide (GO)-based MEG that converts ambient moisture into electricity and further couples MEG discharge with hydrogen evolution. Through nitric-acid treatment, GO is transformed from p-type to n-type acidified GO, enabling an Ohmic contact with the Ni electrode, enhanced hydrophilicity, and efficient proton generation. In the optimized CNT/PEM/aGO/Ni device, moisture adsorption establishes a sustained proton gradient across the asymmetric carbon-based architecture, delivering a steady output of 0.90 V and 0.25 mA cm^{-2} at 80% relative humidity, with stable voltage operation for two weeks under ambient conditions. More importantly, we reveal that proton-electron recombination during MEG discharge produces neutral hydrogen intermediates adsorbed on the carbon nanotube substrate. These intermediates bypass the sluggish initial hydrogen adsorption step in the hydrogen evolution reaction, enabling a discharged CNT electrode to achieve a low overpotential of approximately 20 mV. The device can also be rejuvenated through hydrogen release and re-acidification, supporting cyclic moisture-electric generation and hydrogen production. This work provides mechanistic insight into charge transfer and proton dynamics in MEGs and establishes a cascade energy-conversion concept that links ambient moisture harvesting with sustainable hydrogen generation.

Keywords: Moisture-electric generator; Graphene oxide; Hydrogen evolution reaction; Neutral hydrogen intermediate; Ambient energy harvesting.

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Mengyao Li received her Ph.D. degree from the University of New South Wales (UNSW), Australia. She is currently a Lecturer in the School of Materials Science and Engineering at UNSW. Her research focuses on moisture-electric energy conversion, interfacial electrochemistry, and the development of flexible self-powered devices for sustainable energy and hydrogen generation.

Chao Liu
RMIT University, Australia

Day 3: 12:05-12:17, Oral Talk

Title: Unveil the Roles of Water Molecules in Moisture Electric Generators

Abstract: Moisture electric generators (MEGs)[1-3] have emerged as a promising sustainable energy-harvesting technology capable of directly converting ambient moisture into electrical energy. Here, by integrating mechanism insights and structural engineering from a MXene-derived TiO_2-based system, the roles of water molecules are demonstrated.[1] Through the combination of theoretical calculations involving time dimension on material's moisturizing process and experimental analyses, it is revealed the working principle through the water molecule triple roles in driving moisture electric generators (MEGs): 1) intrinsic H2O absorption on the material surface and splitting into hydroxy group and proton due to the polarizability of the material surface determined by the static electric potential of the materials. This process induces the electrochemical potential difference of the materials via the work function changes; 2) freely diffused protons derived from the H2O splitting work as the ions charge carriers; 3) via the hydrogen bond of the water molecules to drive charge carriers diffuse between opposite electrodes, maintaining the internal circuit current flow. It is successfully unveiled that anatase TiO2 based materials for output voltage changes correlated to the domains' work function's difference, tuning by the surface adsorption species (H, Cl, OH) and anisotropic exposed crystal facets of the material. The structural tuning through HCl treatment enhances charge transfer and output voltage up to 0.8 V.

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Dr. Bo Fu
Griffith University, Australia and Chinese Academy of Sciences, China

Day 3: 12:17-12:29, Oral Talk

Title: Solar-driven Atmospheric Water Production through Hierarchically Ordered Porous Carbon for Self-sustaining Green Hydrogen Production

Abstract: Green hydrogen production by proton exchange membrane water electrolysis (PEMWE) powered by clean energy is a promising and environmentally friendly technology. However, it relies on a high-purity water source, which is limited in regions facing water scarcity.1 Here, we report a coupled self-sustaining solar-enabled system that couples atmospheric water harvesting with PEM water electrolysis (AWH-PEMWE), offering a novel pathway for clean water generation and green hydrogen production. The atmospheric water harvester (AWH) component utilizes N and O co-doped hydrophilic ordered porous carbon, engineered with an interconnected hierarchical porous structure with prosperous channels for efficient mass transport.2 It enables effective interfacial solar evaporation for water release, achieving a record-high water harvesting capacity of 0.49 L kg-1 h-1 at 40% relative humidity (RH). During outdoor tests, the AWH-PEMWE system reaches a peak green hydrogen production rate of 204 mL h-1 at midday using only atmospheric water as feedstock.3 Remarkably, the system remains operational under ultra-low humidity conditions down to 20% RH, addressing the challenge of water availability in arid environments. Importantly, the system operates without the need for carrier gases or external energy input accessories, enabling a fully solar-driven process with zero carbon emission throughout the hydrogen production cycle.

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Room 1: Solar 7

Assoc. Prof. Wallace W. H. Wong
The University of Melbourne, Australia

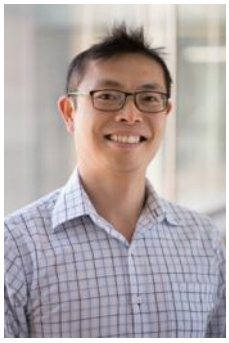
Day 3: 13:30-13:50, Keynote Talk

Title: Designing Molecules for Spectral Engineering in Photovoltaics

Abstract: The primary limitations of photovoltaics (PV) power conversion efficiency are thermalisation and transmission losses tied to the band gap of the semiconducting materials used in these devices. With the silicon PV technology reaching its theoretical limits, the next frontier in driving down the cost of renewable energy generation lies in overcoming these losses. For thermalisation losses, the most studied strategy is to use additional PV junctions with band gap larger than silicon making tandem or multijunction devices. Much work is ongoing with this strategy especially with perovskite PV devices. Another strategy to reduce thermalisation loss is to make use of multiexciton generation mechanisms whereby one high energy exciton is split into 2 or more lower energy excitons. For photons below the PV material band gap, up-conversion can be used to combine low energy photons to produce higher energy photons that can be absorbed by the PV material. We have worked on designing molecules for these spectral engineering approaches over the years – including down-shifting [1], down-conversion, and up-conversion systems [2]. In this talk, I will provide an update on our work and present an outlook on challenges in designing organic dyes and semiconductors for PV spectral engineering applications.

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Biography: Wallace Wong is an Associate Professor in Chemistry and the Energy Materials program leader in the Melbourne Energy Institute at the University of Melbourne. He is the University of Melbourne node co-lead in the Australian Centre for Advanced Photovoltaics working on emerging photovoltaic materials. His core expertise is the design and synthesis of organic semiconducting materials and dyes with applications in light harvesting, solar energy conversion, and chemical sensing. Wallace is experienced in working on collaborative multidisciplinary projects with focus on materials science.

Dr. Munkhbayar Batmunkh
Griffith University, Australia

Day 3: 13:50-14:10, Keynote Talk

Title: Engineering Metal Halide Perovskite Semiconductors for Solar Cells

Abstract: Metal halide perovskites have revolutionized the conventional perception of excellent semiconductors due to their unique electronic, chemical, physical and optical properties, which have opened doors for many applications. A classic example of perovskites' applications is photovoltaic solar cells, which convert sunlight directly into electricity. Despite the great advancements, the commercialization of perovskite solar cell technology is limited due to the issues associated with the stability of perovskite in ambient conditions and heat. Engineering strategies such as additive engineering, defect engineering and surface passivation are promising approaches for not only improving the stability of perovskite solar cells, they are also widely used for enhancing the photovoltaic performances. In this talk, I will present our recent work focused on engineering metal halide perovskite using oxygen-inducing effect and surface passivation methods and their application in solar cells.

Keywords: semiconductors, solar cells, photovoltaic, perovskites, perovskite solar cells, passivation, stability

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Dr. Batmunkh received his PhD degree from the School of Chemical Engineering at the University of Adelaide in 2017. Dr. Batmunkh is a currently Senior Lecturer in the School of Environment and Science at Griffith University. He is an Australian Research Council (ARC) Future Fellow (2026-2030) and leads an active independent research group working on functional materials, solar cells, detectors and their integrated systems. He is a former ARC DECRA fellow (2022-2025). Dr Batmunkh is a QLD 2025 Young Tall Poppy

Dr. Mei Gao
CSIRO Technology, Australia

Day 3: 14:10-14:30, Keynote Talk

Title: Towards Commercialisation of Flexible Perovskite Solar Cells

Abstract: The technology for large-scale industrial manufacturing of perovskite solar cells (PSCs) is rapidly advancing, supported by increasingly precise process control and the development of sophisticated fabrication equipment. Printed PSCs present a transformative pathway for next-generation photovoltaics, enabling lightweight, flexible, and cost-effective energy solutions through high-throughput roll-to-roll (R2R) manufacturing. Through sustained research efforts over many years, CSIRO has developed extensive expertise in this field, encompassing practical know-how, fundamental scientific insights, and a strong portfolio of industry-relevant intellectual property. A broad spectrum of fabrication strategies has been systematically explored and demonstrated, spanning laboratory-scale device optimisation to large-area module fabrication and scalable high-throughput production. Despite significant progress, the power conversion efficiency of flexible PSCs, particularly in large-area modules, remains lower than that of glass-based perovskite solar cell devices/modules. Ongoing research is therefore focused on addressing the intrinsic challenges associated with upscaling, including film uniformity, defect detection/control, and process variability, with the aim of improving both efficiency and long-term operational stability. This presentation will discuss key challenges associated with scaling up large-area modules under diverse processing conditions. It will further highlight the role of AI-assisted optimisation in fast materials screening to enhance device performance and stability, offering new opportunities for accelerating the industrial deployment of perovskite photovoltaic technologies.

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Dr. Mei Gao is a Principal Research Scientist and Team Leader of the Printable Photovoltaics (PV) team at the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Her research expertise spans small molecule and polymer synthesis, surface modification, conducting polymers, and the development of high-sensitivity biosensors based on nanomaterials and, more recently, optoelectronic materials.

Since 2011, Dr. Gao's research has primarily focused on developing organic photovoltaics and perovskite solar cells on flexible substrates, aiming to achieve facile, solution-processable, reproducible, and fully printable high-performance single-junction and module devices through high-throughput roll-to-roll printing processes, with applications ranging from terrestrial power generation to space satellites.

Dr. The Duong
The Australian National University, Australia

Day 3: 14:30-14:45, Invited Talk

Title: Development of Scalable Processes for Perovskite-Silicon Tandem Solar Cells

Abstract: The efficiency of perovskite–silicon tandem solar cells has increased rapidly in recent years, exceeding 35% for devices with active areas of approximately 1 cm²[1]. However, commercialisation requires the development of scalable fabrication processes for all functional layers to enable the transition from laboratory-scale devices to large-area modules. In this work, we address two critical components of tandem device fabrication: the hole transport layer (HTL) and the perovskite absorber layer. For the HTL, we develop a scalable architecture combining sputtered nickel oxide (NiOx) with an evaporated self-assembled monolayer (Me-4PACz). Monolithic two-terminal perovskite–silicon tandem solar cells incorporating the NiOx/evaporated SAM stack achieve a champion power conversion efficiency of 29.6% on 1 cm² devices, outperforming equivalent devices employing NiOx with solution-processed SAM (28.4%) or NiOx alone (26.4%). For the perovskite absorber, we develop a scalable two-step hybrid deposition process consisting of thermal evaporation of the inorganic precursors followed by blade coating of the organic components. Through process optimisation and solvent engineering, we demonstrate perovskite–silicon tandem solar cells with efficiencies exceeding 27% and active areas greater than 20 cm².
These results demonstrate scalable fabrication strategies for both the charge transport and absorber layers of perovskite–silicon tandem solar cells. The approaches presented here provide important pathways towards large-area module manufacturing and support the commercialisation of high-efficiency tandem photovoltaic technology.

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Dr The Duong is a Senior Research Fellow at the School of Engineering, Australian National University (ANU). His research focuses on perovskite and perovskite–silicon tandem solar cells, with expertise in device engineering, scalable manufacturing, interface engineering, and stability. His work aims to improve the efficiency, durability, and manufacturability of next-generation photovoltaic technologies. He has published extensively in leading journals and works closely with academic and industry collaborators to accelerate the development and translation of advanced solar energy technologies.

Dr. Tuquabo Tesfamichael
Queensland University of Technology, Australia

Day 3: 14:45-15:00, Invited Talk

Title: Inorganic Hole Transport Materials for High-performance Inverted Perovskite Solar Cells

Abstract: Perovskite solar cells (PSCs) have been widely investigated in short periods of time due to their excellent photoelectrical performance, flexibility in device design and architecture including mesoscopic, planar heterojunctions, tandem solar cells, conventional (n-i-p) and inverted (p-i-n) structures. While the conventional (n-i-p) architecture appears a dominate device model, the inverted (p-i-n) configuration has recently gained great attention due to its emerging application in semi-transparent PSC devices. This presentation explores advancements of Ni- and Cu-based metal oxide HTLs through doping or interlayer modification for high performance and long-term operational stability of n-i-p semi-transparent PSCs. Various aspects of the HTLs including optical properties, energy gaps, band alignment, deposition techniques and interfacial engineering strategies will be discussed. PSC performance based on e-beam evaporated NiOx, V2O5/NiOx, NiOx/V2O5, CuOx/V2O5 HTLs will be shown and the importance of interfacial engineering and design strategy for efficient and stable photovoltaic devices will be discussed.

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Biography: Dr Tuquabo Tesfamichael is a Senior Lecturer in the School of Mechanical, Medical and Process Engineering (MMPE) at the Queensland University of Technology (QUT). Dr Tesfamichael's research focuses on the optical, electrical, electronic, mechanical and corrosion performance of thin film coatings. He graduated with BSc from Asmara University (Eritrea) in 1989, and a PhD from Uppsala University (Sweden) in 2000 followed by a postdoctoral fellowship and lectureship (2001–2011) at QUT, where he conducted research and development on surface/interface engineering of metal oxides and metallic glass thin films for perovskite solar cells, biomedical implants, and gas sensing applications. He is the author of over 100 peer-reviewed research articles, cited over 4,000 and h-*index* of 34 (Google Scholar).

Dr. Yang Yang
Queensland University of Technology

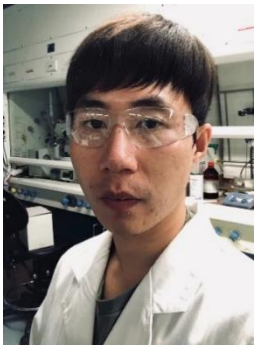
Day 3, 15:00-15:15, Invited Talk

Title: Advancing Carbon Electrode-Based Perovskite Solar Cells from Device Optimisation to Emerging Applications

Abstract: Carbon electrode-based perovskite solar cells (C-PSCs) have emerged as a promising photovoltaic technology owing to the low cost, chemical robustness, and excellent diffusion-barrier properties of carbon electrodes. Compared with conventional metal electrodes, carbon electrodes are well suited to scalable manufacturing and offer the potential to improve device stability while reducing fabrication costs.[1,2] These advantages make C-PSCs strong candidates for the commercialisation and large-scale production of perovskite photovoltaic technologies. In our work, we systematically investigated the device architecture of C-PSCs to enhance their photovoltaic performance, with particular emphasis on carbon electrode engineering through the development of different fabrication strategies and optimization of carbon electrode composition. These efforts enabled the fabrication of low-cost, efficient, and stable C-PSCs.[3] Beyond conventional outdoor photovoltaic applications, we further explored the potential of these devices for integrated energy storage and indoor energy harvesting. By integrating a C-PSC with a supercapacitor through a shared carbon electrode, we developed a monolithic photocapacitor capable of harvesting, storing, and delivering solar energy on demand.[4] Furthermore, the optimised C-PSCs achieved a power conversion efficiency of approximately 40% under 1000 lux warm-white LED illumination, representing the highest efficiency reported for C-PSCs under indoor lighting conditions. Our work highlights the versatility of carbon electrodes and establishes C-PSCs as a promising platform for scalable photovoltaics, integrated energy-storage systems, and high-efficiency indoor energy harvesting.

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Dr. Yang Yang received his Ph.D. at School of Chemistry and Physics, Faculty of Science, Queensland University of Technology, Australia, in 2021, and M.S. from China University of Mining and Technology, China, in 2016. He is currently a Postdoctoral Research Fellow at Queensland University of Technology, Australia. His research topic is on the perovskite solar cells using carbon electrodes, semitransparent perovskite solar cells, energy storage devices, and perovskite-based integrated devices.

Room 2: Thermoelectric Materials 2

Prof. Min Hong
University of Southern Queensland, Australia

Day 3: 13:30-13:50, Keynote Talk

Title: Phonon Engineering for High-Performance Thermoelectric Materials

Abstract: Thermoelectric technology offers sustainable solutions for power generation, waste-heat recovery, and refrigeration. Improving the thermoelectric figure of merit (zT) is essential for enabling its widespread commercial application. Unlike electrical conductivity and the Seebeck coefficient, which are coupled through electron transport, lattice thermal conductivity (□l) is governed by phonon transport. Therefore, reducing κ_l provides an effective pathway to enhance zT. Our research has developed mechanisms to strengthen phonon scattering and suppress □l. First, we established a strategy for tuning phonon dispersion to enhance intrinsic phonon–phonon scattering in Sb-alloyed GeTe.1-2 Second, conventional point defects and grain boundaries scatter high- and low-frequency phonons, respectively, leaving mid-frequency phonons less affected. To address this limitation, we introduced high-density dislocations into Bi2Te3 through mechanical plastic deformation and generated stacking faults in AgSbTe2 by controlling the synthesis process.3-4 Third, high-density planar vacancies and superlattice precipitates were created in GeTe-based materials to further broaden the phonon-scattering spectrum.5 Advanced electron microscopy and density functional theory calculations were employed to reveal the relationships between structural imperfections, phonon transport, and reduced □l. These approaches resulted in enhanced zT across multiple thermoelectric material systems. The established phonon-engineering strategies provide applicable routes for tailoring thermal transport and improving thermoelectric performance.

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Biography: Min Hong is a Professor and ARC Future Fellow at University of Southern Queensland, Australia. His research focuses on thermoelectric technology, including semiconductor thermoelectric materials, organic/inorganic flexible thermoelectrics, physical/chemical principles of transport properties, and thermoelectric devices for refrigeration and power generation. As the leading author, he has secured publications in Joule, Energy & Environmental Science, Advanced Materials, Advanced Energy Materials, Journal of the American Chemical Society, Accounts of Chemical Research, etc. He has also obtained funding of ARC Future Fellow, DECRA, Discovery Project, ARC Research Hub as a node CI, AEA Ignite, and iLaunch Trailblazer project.

Prof. Lei Miao
Guangxi University, China

Day 3: 13:50-14:10, Keynote Talk

Title: Engineering GeTe-Based Thermoelectrics: Synergistic Optimization of Thermodynamics and Electron–Phonon Transport

Abstract: Thermoelectric (TE) technology offers a promising solution for waste heat recovery due to its solid-state operation without noise or moving parts. GeTe-based alloys are among the most attractive mid-temperature TE materials because of their excellent electronic transport properties and tunable band structures. However, their practical application is hindered by strong electron-phonon coupling, phase-transition-induced instability, and poor device interface reliability. To address these challenges, this work integrates theoretical design, microstructural engineering, and device optimization. First, an electron-phonon decoupling strategy based on local charge transfer was developed through Sb/Cu/Pb co-doping. Local charge redistribution suppressed Ge off-center displacement, promoted band convergence, and enhanced phonon scattering via multiscale defects. Consequently, $Ge_{0.83}Sb_{0.1}Cu_{0.01}Pb_{0.06}Te$ achieved a peak ZT of ~2.35 at 773 K with improved mechanical properties. Second, high-density ferroelectric domain walls were introduced by high-energy ball milling to further suppress lattice thermal conductivity. The domain-wall-induced microstrain fields strongly scattered low- and mid-frequency phonons while maintaining excellent electrical transport. Combined with compositional optimization, $Ge_{0.84}Sb_{0.1}Cu_{0.01}Pb_{0.05}Te$ reached a record peak ZT of ~2.9 at 773 K and an average ZT of ~1.9 over 323–823 K, together with outstanding thermal cycling stability. Finally, a high-throughput interface screening strategy identified SnTe as an effective diffusion barrier. The spontaneously formed composition-gradient buffer layer suppressed elemental interdiffusion and relieved thermal stress, significantly improving device reliability. A single-leg device achieved a conversion efficiency of ~16.4%, while a GeTe–PbTe module delivered a maximum power density of 0.52 W cm^{-2} and a conversion efficiency of ~9.2% under a temperature difference of 477 K. Overall, this work establishes an integrated framework linking theoretical design, material optimization, and device engineering, providing effective strategies for developing high-performance and reliable GeTe-based thermoelectric materials and devices.



Dr. Lei Miao received a Ph.D. degree from Nagoya Institute of Technology (NITtech.), Japan. She is currently working as the professor in Guangxi University since 2023.06. Her current research focuses on energy conversion materials& devices, especially on thermoelectric and solar thermal applications. Dr. Miao has published over 330 scientific papers, including papers on Nature Comm., Sci Adv., Energy Environ. Sci., Adv. Energy Mater., 6 books, 8 awards. Over 55 authorized Chinese and Japanese patents, over 60 invited speeches in international conferences and etc.

Dr. Qian Liu
Queensland University of Technology, Australia

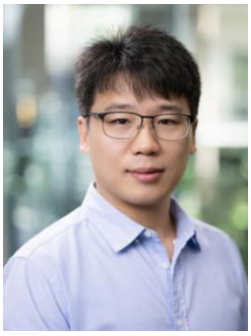
Day 3: 14:10-14:25, Invited Talk

Title: High-Performance SWCNTs/Organic Hybrid Thermoelectric Materials

Abstract: Single-walled carbon nanotubes (SWCNTs) are promising flexible thermoelectric materials capable of directly converting industrial waste heat and temperature gradients in extreme environments into electricity.[1-2] However, their strong self-aggregation severely limits thermoelectric performance. SWCNTs/organic hybridization offers a compelling pathway to address this challenge, owing to the structural versatility of organic materials and their rich intermolecular interactions. Despite this potential, the lack of efficient organic components has constrained the power factor (PF) of most reported SWCNT-based composites to below 10 μW cm−1 K−2, with only a few examples achieving 20 μW cm−1 K−2.[3-4] These values remain well below the typical threshold (≥ 40 μW cm−1 K−2) for high-performance inorganic thermoelectrics at room temperature. Here, we will present two molecular engineering strategies to overcome these limitations. First, by introducing stable free radicals into the side chains of donor-acceptor (D-A) conjugated molecules, we achieve significantly improved SWCNTs dispersion via synergistic effects of the π interactions between SWCNT and D-A conjugated backbone and the radical-radical coupling interactions, leading to a PF exceeding 30 μW cm−1 K−2. Second, we develop hydrogen-bonding-rich covalent organic frameworks (COFs) that act as seed cores to direct the formation of well-connected, grid network-confined SWCNTs architectures. This spatially regulated structure further enhances PF above 45 μW cm−1 K−2. These results demonstrate that rational molecular design of organic components can effectively modulate nanoscale organization and manage charge/heat transport in SWCNT hybrids, establishing a versatile platform for high-performance thermoelectric materials and advancing sustainable energy technologies.

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Dr. Qian Liu is an ARC DECRA Fellow whose research focuses on the molecular engineering of emerging organic semiconductors for functional electronic devices. His work aims to tailor molecular structures to achieve targeted functionalities across a wide range of applications, including organic transistors, thermoelectrics, photovoltaics, and (bio)sensors. By integrating advanced characterization techniques with device engineering, he elucidates the relationships between molecular structure, electronic properties, and device performance. His research provides fundamental design principles for next-generation organic semiconductors and accelerates their translation from fundamental discoveries to multifunctional, real-world applications.

Tairan yang
RMIT University, Australia

Day 3: 14:25-14:37, Oral Talk

Title: Bilayer D-Ni/PVA/SA Aerogel for Efficient Solar Evaporation

Abstract: Solar-driven interfacial evaporation has emerged as an attractive approach for sustainable freshwater production. However, its efficiency is often limited by inadequate water transport, poor interfacial heat confinement, and unfavorable water states within porous evaporators[1-5]. Herein, we report a bilayer nickel-coated diamond/polyvinyl alcohol/sodium alginate (D-Ni/PVA/SA) aerogel fabricated through directional freezing, freeze-drying, and Ca2+ crosslinking. The D-Ni-enriched upper layer functions as an efficient photothermal interface, while the porous polymer bottom layer provides continuous water supply through vertically aligned channels. Raman analysis revealed that incorporating D-Ni effectively regulated the water state by increasing the intermediate-to-bound water ratio, with D-Ni-2 exhibiting the highest value of 6.50, indicating enhanced water mobility and reduced evaporation resistance. Benefiting from the synergistic regulation of water transport and heat localization, D-Ni-2 achieved an evaporation rate of 2.74 kg m^{-2} h^{-1} under one-sun illumination, corresponding to an apparent solar-to-vapor efficiency of 140.38%. Compared with the homogeneous D-Ni-2-H aerogel, the bilayer structure generated a significantly larger temperature gradient between the top and bottom surfaces, confirming more efficient interfacial heat confinement and suppressed heat dissipation into bulk water. Furthermore, the evaporator maintained stable performance over 500 min of continuous operation and demonstrated excellent salt tolerance in 5–20 wt% NaCl solutions. This work demonstrates that coupling bilayer structural engineering with water-state regulation provides an effective strategy for enhancing solar steam generation, offering a promising platform for high-performance seawater desalination.

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Shihang Ma
RMIT University, Australia

Day 3: 14:37-14:49, Oral Talk

Title: Synergistic photothermal and thermal management in h-BN/CB engineered PVA aerogels for high-efficiency solar desalination

Abstract: Solar-driven interfacial evaporation (SDIE) has emerged as a promising strategy for sustainable water purification; however, its practical application is still limited by inefficient heat utilization and high evaporation enthalpy of water (1-5). Herein, a three-dimensional (3D) aerogel evaporator is developed via the integration of polyvinyl alcohol (PVA), carbon black (CB), and boron nitride nanosheets (BNNS), aiming to synergistically regulate light absorption, heat transfer, and interfacial water states. The introduction of CB enables efficient broadband solar absorption and photothermal conversion, while BNNS constructs thermally conductive pathways to facilitate heat transfer and suppress heat loss to bulk water. Meanwhile, the aligned porous structure derived from directional freeze-drying ensures continuous water transport. More importantly, Raman analysis reveals an increased intermediate water/free water (IW/FW) ratio, indicating weakened hydrogen bonding and reduced evaporation enthalpy. Benefiting from these synergistic effects, the optimized aerogel achieves a high evaporation rate of 3.2 kg m^{-2} h^{-1} under 1 sun irradiation. In addition, the system exhibits excellent salt tolerance, stable performance under varying solar intensities, and effective removal of both ions and organic pollutants (e.g., Rhodamine B and Methyl Orange), with the collected water meeting drinking water standards. Outdoor experiments further confirm its reliable operation under practical conditions. This work provides an effective strategy for constructing high-efficiency 3D evaporators through the combined regulation of thermal management and water-state engineering, offering great potential for real-world solar-driven water purification.

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Tao Yin
University of New South Wales, Australia

Day 3: 14:49-15:01, Oral Talk

Title: Accelerating water desorption at heterostructure interfaces for high-rate solar evaporation

Abstract: Solar-driven interfacial evaporation represents a sustainable and cost-effective pathway for water purification, yet how to accelerate kinetics of water molecule desorption on the surface of photothermal materials remain a critical and largely overlooked bottleneck. Here, we report a dual-phase photothermal heterostructure designed to accelerate desorption and substantially boost solar-to-vapor efficiency. By tailoring the coordination between surface Ga3+ sites on eutectic gallium indium (EGaIn) and oxygen-containing groups on graphene oxide (GO), we construct a GO/Ga2O3 interface that minimizes bonding with water molecules, thereby lowering the energy barrier for vapor escape. The resulting thin-film evaporator achieves an evaporation rate of 3.64 kg m−2 h−1 with 95.3% conversion efficiency under 1 sun irradiation. Optimizing the geometry to a high-aspect-ratio configuration further elevates performance to 7.54 kg m−2 h−1 at an efficiency of 96.2%. The system demonstrates exceptional long-term stability, maintaining stable operation over 30 days under indoor conditions and 60 days outdoors, while retaining alongside robust self-cleaning properties and resilience in harsh environments. This work establishes surface desorption management through heterostructure engineering as a primary strategy for scalable, high-performance solar evaporation technologies with implications for green energy and global water security.

Room 3: Catalyst 8

Prof. Dawei Su
RMIT University, Australia.

Day 3: 13:30-13:50, Keynote Talk

Title: Unveiling the material's photo/electrochemical properties correlated with its electronic structures

Abstract: Structure (from atomic and electronic level)-performance correlation demonstrates the crucial impact of complex surface chemistry and nanostructure on photo/electrochemical performance, which is also a persistent barrier for rationally designing photo/electrode materials. Rationally designing materials for their superior photo/electrochemical properties can only rely on the unveiling of the correlation between their electronic structures' evolution along the testing processes. Therefore, from the electronic level to develop the spatial- and time-resolved light interaction technology can be deeply understood. Therefore, here I showcase several recent works about investigating the intrinsic properties of the materials correlated with their subtle micro-structure variation, including 1-3.

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Assoc. Prof. Fengwang Li
The University of Sydney, Australia

Day 3: 13:50-14:10, Keynote Talk

Title: Unlocking Stable and Efficient Green Hydrogen from Ammonia

Abstract: Ammonia is a premier medium for transporting green energy, but unlocking its hydrogen content via electrochemical cracking is currently hindered by catalyst instability and high energy consumption. This presentation outlines two catalyst design strategies that overcome these barriers to establish a practical route for decentralized hydrogen production. First, we demonstrate a facet engineering approach using pulsed electrodeposition to synthesize dendritic Platinum nanostructures dominated by Pt(100) facets. By shifting the rate-determining step to facilitate *N desorption, this catalyst resists surface poisoning, delivering a record 500 hours of stable operation at room temperature. Second, we report a dynamic self-activation mechanism on Pt-decorated NiFe foams. Contrary to the typical decay observed in ammonia oxidation, these anodes increase in activity during operation, driven by a continuous bias-induced reconstruction of the Ni(OH)2/NiOOH interface. This dynamic renewal suppresses poisoning and enables industrial-level current densities of up to 3 A/cm2 at 80 □C. Together, these technologies achieve specific energy consumptions competitive with centralised thermal cracking, effectively unlocking a viable pathway for the green hydrogen economy.



Biography: Dr. Fengwang Li is an Associate Professor and Future Fellow at the University of Sydney. With a PhD from Monash University and postdoctoral training from the University of Toronto, his research focuses on electrochemical transformation of Earth-abundant feedstock into valuable chemicals and sustainable fuels, aiming for a net-zero emission future. Li has published over 100 peer-reviewed articles in top journals, including Nature and Science. His accolades include the 2025 RACI Materials Chemistry Award, Australian Academy of Science Le Fevre Medal, 2024 RACI A.M. Bond Medal, and 2023 Australian Museum Eureka Prize for Outstanding Early Career Researcher.

Dr. Xiaoyang Wang
Guangxi University, P. R. China

Day 3: 14:10-14:25, Invited Talk

Title: Engineering Efficient Carrier Transport through Synergistic Photo-Thermoelectric Catalytic Effect

Abstract: Multi-field synergistic catalysis is regarded as a cutting-edge strategy to boost energy utilization efficiency and address the limitations of single-field catalytic systems. Nevertheless, the sluggish migration and severe recombination of charge carriers caused by unsatisfactory field coupling seriously restrict the practical performance of multi-field catalytic platforms. To solve the bottleneck of inefficient carrier transport, a high-performance n-type TiO2/Ag2.3Se photothermoelectric (PTE) hybrid catalyst was rationally constructed in this work via integrating photocatalytic and thermoelectric functional units. A stable 40 °C temperature gradient was built on the catalyst surface, which generates a robust internal electric field driven by the Seebeck effect and effectively regulates the carrier transport behavior. The synergistic photo-thermoelectric coupling endows the composite with a prominent PTE photovoltage of 2.3 mV, which is much higher than the simple sum of pure thermovoltage (1.4 mV) and photovoltage (0.3 mV). In-situ Raman spectroscopy combined with finite element method simulations verifies that the dual-field synergy induces highly directional carrier flux, realizing the effective suppression of photogenerated charge recombination and the acceleration of interfacial catalytic reaction kinetics. Benefiting from the optimized carrier transport efficiency, the TiO2/Ag2.3Se hybrid achieves an excellent photocatalytic degradation efficiency of 93%, which is far superior to the independent photocatalysis (41%) and thermoelectric catalysis (13%) performances. The distinct “1+1>2” synergistic effect confirms that waste thermal energy can be converted into a valid driving force for charge separation and transport, breaking the performance limitation of single photocatalysis. This work clarifies the intrinsic mechanism of thermal-induced interfacial charge transfer and carrier regulation, and provides a feasible engineering strategy for the design and fabrication of high-efficiency waste-heat-driven composite catalysts for environmental remediation and sustainable energy utilization.



Xiaoyang Wang is an assistant professor of the School of Physical Science and Engineering at Guangxi University. He obtained his bachelor’s and master’s degrees from East China University of Science and Technology. He received his PhD degree from University of Chinese Academy of Sciences. Then he worked as assistant professor at the Nagoya University and Tokyo University of Science, before joining Guangxi University in 2023. His research interests mainly include energy physics and catalysis

Muhammad Abid Amin
University of Wollongong, Australia

Day 3: 14:25-14:37, Oral Talk

Title: Dynamic Spin-Adaptive Matching via Alternating Magnetic Fields for Accelerated Oxygen Electrocatalysis on Gd-NiFe-LDH

Abstract: Nickel-iron layered double hydroxides (NiFe-LDHs) are widely considered high-performance transition-metal electrocatalysts for the oxygen evolution reaction (OER), yet their activity is often limited by sluggish reaction kinetics and mass transport. Most previous studies have focused on magnetic field (MF) effects linked to the intrinsic magnetic properties of the catalyst. Here, we show that an alternating magnetic field (AMF) can be used to dynamically tune the catalytic microenvironment and improve OER performance. To make the catalyst magnetically responsive, we incorporate gadolinium (Gd) into NiFe-LDH, taking advantage of the high-spin 4f^7magnetic configuration of Gd3+ to enhance local magnetic moments and magnetic susceptibility without altering the baseline room-temperature paramagnetic ground state. Vibrating sample magnetometry (VSM) measurements confirm a clear increase in local magnetic susceptibility: after 3 at.% Gd doping, the mass magnetization rises from 0.01 to 0.43 emu g-1. Under 196.4 Oe AMF at 246 kHz, the overpotentials at 10 and 100 mA cm-2 are reduced by 27.9% and 35.9%, respectively, compared with the no-field conditions. This enhancement likely arises from a combination of field-induced local spin polarization, mediated by Gd-induced magnetic interactions under AMF, which promotes triplet oxygen formation, together with a partial contribution from magnetothermal heating. Overall, these results point to AMF as a promising new direction in magnetic-field-assisted electrocatalysis.

Keywords: (oxygen evolution reaction, water splitting, NiFe LDH, alternating magnetic field)

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Tianyang Wang
University of Auckland, New Zealand

Day 3: 14:37-14:49, Oral Talk

Title: Developing polymer-encapsulated Nickel-doped Magnesium nanoparticles for solid-state hydrogen storage

Abstract: For efficient, controllable, and safe hydrogen storage, light metal–based materials have drawn considerable attention as hydrogen intermediates for storage and transportation [1]. Among them, Magnesium, with its high theoretical hydrogen storage capacity, natural abundance, and environmental friendliness, is regarded as a promising candidate [2]. However, bulk Mg, with high thermodynamic stability and sluggish reaction kinetics, requires impractically high temperatures for hydrogen absorption and desorption [3]. In this work, we investigate the effects of nickel-doped Mg nanoparticles wrapped in polymer encapsulants, which provides effective protection, avoiding the ignition of Ni/Mg nanoparticles in the air. Pre-nucleated Ni atoms, possessing a stronger reduction potential, act as preferential growth sites to catalyze hydrogen generation. Meanwhile, the as-prepared Ni/Mg particles with particle size approximately 6 nm beneficial to increase the kinetic energy for hydrogen diffusion. Finally, the as-prepared sample achieves a hydrogenation capacity of 3.5 wt% at 250 °C under a hydrogen pressure of 3 MPa. This study demonstrates a synergistic strategy that combines interfacial engineering with polymer encapsulation, offering insights into the design of air-stable high-performance Mg-based hydrogen storage materials and next-generation energy storage technologies.
Keywords: Hydrogen storage, Nano magnesium, Synergistic effect

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Room 4: Optoelectronic 4

Prof. Qing Shen
The University of Electro-Communications, Japan

Day 3: 13:30-13:50, Keynote Talk

Title: Lead-Free Perovskite Quantum Dots for Next-Generation Optoelectronics: Defect Engineering and Photophysical Properties

Abstract: Lead-free halide perovskite quantum dots (QDs), such as Sn-based and double perovskite systems, have emerged as environmentally benign alternatives to traditional lead-based perovskites. Despite their tunable bandgaps and strong light absorption, achieving high crystal quality and mitigating trap-mediated recombination remain critical challenges. This talk highlights our recent advances in the synthesis, surface passivation, and photophysical characterization of phase-stable, low-defect lead-free perovskite QDs with enhanced photoluminescence quantum yields (PL QYs) and prolonged carrier lifetimes[1-6]. By implementing targeted strategies such as Sn(IV) suppression and metal ion doping, we successfully minimized lattice distortion and detrimental defects. Ultrafast transient absorption (TA) and time-resolved photoluminescence (TRPL) spectroscopies confirmed negligible electron or hole trapping in these optimized samples. Notably, we developed Sb^{3+}/Mn^{2+} co-doped $Cs_2NaInCl_6$ double perovskite QDs that exhibit efficient broadband white-light emission via self-trapped excitons. This co-doping approach effectively suppresses cation disorder, yielding a PL QY approaching 100%. To translate these superior photophysical properties into high-performance optoelectronic devices, short-chain ligand exchange was utilized. This surface engineering enhanced film conductivity by nearly 20-fold and reduced the hole-injection barrier by 0.4 eV. Consequently, we demonstrated light-emitting diodes (LEDs) with an external quantum efficiency (EQE) of 0.86%, representing the highest value reported to date for double perovskite QD-based LEDs. Collectively, these findings provide key design principles for engineering high-efficiency, stable, and eco-friendly perovskite optoelectronics.

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Professor, Qing Shen

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Biography

Qing Shen is a Professor of Physics at the University of Electro-Communications. She received her B.S. and M.S. degrees in Physics from Nanjing University in 1987 and 1989, respectively, and earned her Ph.D. degree in Applied Chemistry from the University of Tokyo in 1995. She subsequently continued her research at the University of Tokyo as a JSPS Research Fellow for Young Scientists (PD) and as a Research Assistant. In 1996, she joined the University of Electro-Communications, where she was promoted to Full Professor in 2016. From 2009 to 2015, she concurrently served as a researcher in the Precursory Research for Embryonic Science and Technology (PRESTO) program, “Photoenergy Conversion Systems and Materials for the Next Generation Solar Cells,” under the Japan Science and Technology Agency (JST). As of 2025, she has published more than 340 peer-reviewed papers and 14 book chapters, with an h-index of 74 and over 21,000 citations.

Her current research focuses on (1) quantum dots and their applications in optoelectronic devices, (2) mechanistic studies aimed at improving the efficiency of solar cells and LEDs, and (3) interface engineering to enhance the efficiency of solar cells and LEDs. She has received several prestigious awards, including the JASP Young Scientist Award (1997), the JSTP Best Paper Award (2003), the USE Young Scientist Award (2003), and the JSAP Excellent Women Scientist Award (2014). Her research centers on the development of novel functional materials for next-generation solar cells and LEDs, particularly focusing on quantum dots, perovskite solar cells, ultrafast charge-carrier dynamics, and interface engineering.

Research Interest:

Functional materials for next-generation photovoltaics and LEDs; quantum dot optoelectronics ; perovskite solar cells; interface engineering; ultrafast spectroscopy and carrier dynamics.

Representative Publications

1. S. Chen, Y. Li, Y. Yang and Q. Shen* et al., *Adv. Mater.*, **2025,** e10643.
2. Y. Li and Q. Shen* et al., *Adv. Funct. Mater.***, 2025**, 35, 2415735.
3. D. Wang, Y Li, and Q. Shen* et al., *eScience*, **2025**, 5, 100279.
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Assoc. Prof. Shery Chang
University of New South Wales, Australia

Day 3: 13:50-14:10, Keynote Talk

Title: Mechanisms of Structural Evolution in Lead-Free Halide Perovskites Uncovered by In Situ Multimodal Microscopy

Abstract: Metal halide perovskites have attracted significant interest for optoelectronic applications, but the toxicity and environmental instability of conventional lead-based materials have driven the development of lead-free alternatives. All-inorganic copper halides, including $CsCu_2Cl_3$ and $Cs_3Cu_2Cl_5$, are promising candidates due to their strong self-trapped exciton emission and improved stability [1-3]. Here, we combine in situ transmission electron microscopy (TEM) and synchrotron-based diffraction to investigate the structural stability and transformation mechanisms of $CsCu_2Cl_3$ and $Cs_3Cu_2Cl_5$ under electron irradiation and ambient-like environments. We first established their electron-beam tolerance to distinguish intrinsic environmental transformations from beam-induced changes. Electron diffraction and high-resolution TEM revealed substantially greater beam stability than all-inorganic lead halide perovskites, with degradation pathways strongly influenced by crystal dimensions and surface ligands. Under humid conditions, the two phases exhibit markedly different behaviour. $Cs_3Cu_2Cl_5$ undergoes rapid transformation to $CsCu_2Cl_3$ upon water exposure, whereas $CsCu_2Cl_3$ remains structurally stable even after prolonged exposure. In situTEM further reveals the nanoscale transformation pathways during water-vapour exposure and their reversal upon heating.
These results demonstrate how in situ and multimodal characterisation can directly resolve dynamic structural transformations and degradation mechanisms in beam-sensitive materials, providing insights for designing stable, lead-free optoelectronic materials.

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Biography: Shery Chang is an Associate Professor in the School of Materials Science and Engineering and Acting Director of the Electron Microscope Unit at University of New South Wales (UNSW), Australia. She obtained her Ph.D. in Materials Science from the University of Cambridge and has held research positions across leading international institutions in the United States, Germany, and the United Kingdom. Her research advances the frontiers of transmission electron microscopy and spectroscopy by combining correlative imaging and machine learning to reveal how atomic-scale structure governs materials functionality. Her work addresses key challenges in fluorescent, optoelectronic, and quantum materials.

Prof. Jin Chang
Nanjing Tech University, China

Day 3: 14:10-14:25, Invited Talk

Title: Crystallization Regulation for Efficient Tin-based Perovskite LEDs

Abstract: Environmentally friendly tin-based perovskites have emerged as promising candidates for optoelectronic applications such as light-emitting diodes (LEDs). However, their performance still lags far behind that of lead-based counterparts, mainly due to the high defect density caused by uncontrolled film crystallization. Here, we reveal the crystallization dynamics and defect formation mechanisms of tin-based perovskite films through in-situ spectroscopic analysis, and develop effective strategies to regulate the crystallization and suppress defects, thereby significantly enhancing LED efficiency. First, we revealed that rapid aggregation of nuclei or small grains during crystallization is one of the major source of defects. By introducing vitamin B1 additives into precursor solutions, we suppressed the grain aggregation and defect formation, achieving an external quantum efficiency (EQE) of 8.3% in a tin-based perovskite near-infrared LED.[1] Second, by precisely controlling the crystallization kinetics of two-dimensional (2D) and three-dimensional (3D) tin perovskite phases, we fabricated 3D/2D epitaxial heterojunction films on ITO substrates. This approach minimized the 3D/2D interfacial defects and boost he EQE to 11.6%.[2] Third, we elucidated how conventional PEDOT:PSS substrates influence crystallization orientation via interactions between PEDOT+ cations and [SnI3]nn- anions, which induce bottom-up crystallization and granular morphology. By modifying PEDOT:PSS with citrates, we weaken these interactions, slow the nucleation at the bottom interface, and enable top-down crystallization, yielding smooth, compact films with lower defect density. This strategy leads to a record-high EQE of 12.8% for tin-based perovskite near-infrared LEDs.[3] Our findings provide mechanistic insight into tin perovskite crystallization and offer generalizable pathways for defect control, paving the way for high-performance lead-free perovskite optoelectronics.

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Prof. Jin Chang received his Ph.D. degree in Nanotechnology and Molecular Science from Queensland University of Technology in 2013. Then, he worked as a postdoctoral researcher at the University of Electro-Communications in Japan from 2013 to 2015. After that, he joined the Institute of Advanced Materials (IAM) and the School of Flexible Electronics (Future Technologies) of Nanjing Tech University in China. His current research interests mainly include lead-free perovskite light-emitting diodes and non-toxic metal halide scintillators for X-ray detection/imaging.

Qimu Yuan
University of Oxford, United Kingdom

Day 3: 14:25-14:37, Oral Talk

Title: Amplified Spontaneous Emission in Vacuum-Deposited CsPbBr3: Insights into Crystallisation Control and Defect Formation

Abstract: Metal halide perovskites (MHPs) have emerged as favourable materials for light-emission applications due to their excellent photoluminescence yield and strong optical gain. While high-performance perovskites are typically fabricated via solution-processing routes, vacuum deposition offers a solvent-free, scalable, and industry-compatible alternative, well-suited for the deposition and integration of homogeneous and reproducible MHP thin films into complex optoelectronic devices [1, 2]. Despite recent demonstrations of low-threshold amplified spontaneous emission (ASE) from vacuum-deposited CsPbBr3, the relationship between thin-film crystallisation, impurity phase formation (i.e. CsPb2Br5 and Cs4PbBr6), and ASE performance remains poorly understood. Therefore, in this work, we systematically varied the precursor flux ratios of CsBr:PbBr2 (Cs:Pb) from 0.85:1 to 3:1 during thermal co-evaporation. By coupling photophysical characterisations with scanning transmission electron microscopy, we identified the flux ratio as a key parameter in governing both atomic-scale defects and microstructural properties, while establishing direct links with the optoelectronic performance of the bulk film. Both Cs-deficient (Cs:Pb $\leq$ 1:1) and excessively Cs-rich (Cs:Pb $\geq$ 2:1) conditions promote the formation of impurity phases, resulting in undesirable morphologies and inconsistent microstructures. Moreover, Cs-rich films exhibit Ruddlesden–Popper (RP) planar defects that act as non-radiative recombination centres. These findings are well-correlated to the observed higher ASE thresholds [3, 4].
In contrast, optimised films grown under a slight CsBr excess exhibit enhanced microstructural uniformity, as evident by compact morphologies and large grains exceeding 500 nm. The relative suppression of secondary phases and RP defects translates to enhanced photoluminescence emission and optical absorption, and hence, reduced ASE thresholds as low as 30.9 μJ cm-2 on z-cut quartz substrates [3]. These results demonstrate that precise control over precursor stoichiometry during vacuum deposition provides an effective route to engineer microstructural and emission properties of CsPbBr3 thin films, and thus establishing promising aspects for vacuum-processed perovskites towards applications of low-threshold lasers and integrated photonic devices.

Key words
Vacuum Deposition, Metal Halide Perovskites, Defects, Amplified Spontaneous Emission

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Room 5: Battery 6

Dr. Xiaodan Huang
Flinders University, Australia

Day 3: 13:30-13:50, Keynote Talk

Title: Mesoporous Separator Engineering Rectified Electrolyte Chemistry for Durable Non-Aqueous Aluminium-Ion Batteries

Abstract: Rechargeable non-aqueous aluminium-ion batteries (AIBs) are promising low-cost and sustainable energy storage systems, but their development is hindered by sluggish transport of strongly associated chloroaluminate ions and unstable aluminium plating/stripping. Here we demonstrate that engineering the separator microenvironment effectively regulates electrolyte chemistry and interfacial ion transport in AIBs. A binder-free dendritic mesoporous silica-modified glass fiber (DMS-GF) separator is developed by growing DMS nanoparticles directly at the GF scaffold surface. The resulting silanol-rich mesoporous architecture weakens anion-cation interactions in chloroaluminate electrolytes, promotes ion dissociation, and shifts electrolyte speciation towards the electrochemically active Al2Cl7- species, leading to enhanced ionic mobility. The interconnected mesoporous channels further homogenise ion transport and electrolyte distribution, enabling highly reversible and stable aluminium plating/stripping with suppressed dendrite growth. In graphene//Al full batteries, the DMS-GF separator enables high reversible capacity, improved rate capability, and long-term cycling stability, outperforming pristine GF separators. This work demonstrates that separator microenvironment engineering can synchronously regulate electrolyte chemistry and interfacial electrochemical processes for high-performance AIBs, providing a promising strategy for controlling ion transport in unconventional battery systems.

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Biography: Dr Xiaodan Huang is an ARC Future Fellow, currently working at the College of Science and Engineering, Flinders University. He is a materials chemist with expertise in the synthesis of functional nanostructured materials for applications in energy storage and environmental technologies. Dr Huang received his PhD in Inorganic Chemistry from Fudan University, China, in 2012. He has since held full-time research positions at Australian institutions, beginning at the University of Technology Sydney (2012-2014) and then at The University of Queensland (2015-2025).

Dr. Zengxia Pei
The University of Sydney, Australia

Day 3: 13:50-14:10, Keynote Talk

Title: Polymeric Gel Electrolyte Design for Efficient Zn Batteries

Abstract: Aqueous zinc metal batteries (AZMBs) are being scrutinized as a compelling solution to support the full vision of sustainable energy storage.1-4 The nature of electrolytes with AZMBs not only defines the chemical environment for the battery reactions but also influences the thermodynamics and kinetics of electrode processes.1-4 In recent years, polymer electrolytes have been widely investigated in various types of Zn batteries due to their unique physicochemical properties. In this talk, I will present our recent advances in the design of functional polymer electrolytes for efficient Zn batteries, including those availing the desolvation of Zn2+ charge carriers, promoting ion conduction, solid-state single Zn2+ conductors, high entropy electrolytes, and the intrinsic catalytic properties of typical polymer electrolytes.3-10

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Biography: Dr Zengxia Pei is a Lecturer and ARC Future Fellow at the School of Chemical and Biomolecular Engineering, University of Sydney (USYD). He leads a research group working on nanomaterials for sustainable energy storage and conversion, with special interests in aqueous batteries, polymer electrolytes, as well as electrocatalysis. Dr Pei received his PhD from City University of Hong Kong in 2017. He joined USYD in 2018 as a USYD Vice-Chancellor's Research Fellow, and later he secured the ARC DECRA Fellowship in 2019. He has been consecutively recognized as a Global Highly Cited Researher (Top 1%) in 2020-2025, and was named the Australian Research Top Rising Star (1 out of 5 in Chemical/Material Science) from 2019 to 2021. Dr. Pei was also awarded the USYD Vice-Chancellor’s Award for Excellent Early Career Researcher in 2023.

Dr. Nana Wang
University of Technology Sydney, Australia

Day 3: 14:10-14:30, Keynote Talk

Title: Engineering Sulfur Reaction Pathways for High-Energy Metal–Sulfur Batteries

Abstract: Metal–sulfur batteries offer high theoretical energy densities but remain limited by polysulfide shuttle, sluggish conversion kinetics, and challenges under practical sulfur-loading and lean-electrolyte conditions. Here, we explore sulfur chemistry from electrolyte-mediated conversion in Li–S batteries to cathode-confined quasi-solid-state conversion in room-temperature Na–S batteries. In ether-based Li–S systems, low-tortuosity conductive carbon architectures regulate polysulfide transport while maintaining rapid solution-mediated conversion, enabling high sulfur loading. In carbonate-based Na–S systems, suppressing bulk polysulfide dissolution shifts the reaction toward localized quasi-solid-state conversion, where sluggish sulfur redox becomes a major kinetic bottleneck. Catalytic regulation, particularly through engineered undercoordinated Mo sites, promotes electron transfer and accelerates reversible conversion of short-chain sulfur species. These studies demonstrate that controlling sulfur reaction pathways through integrated electrode architecture, electrolyte chemistry, and catalytic-site engineering provides a general strategy toward practical high-energy metal–sulfur batteries.
Keywords: Metal–sulfur batteries; Li–S batteries; Na–S batteries; Quasi-solid-state conversion; Electrocatalysis

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Dr. Qingbing Xia
The University of Queensland, Australia

Day 3: 14:15-14:30, Invited Talk

Title: Elucidating Sodium Ion Storage Mechanisms in Hard Carbon Anodes at the Electronic Level

Abstract: Sodium-ion batteries (SIBs) have emerged as a highly promising technology for large-scale electrochemical energy storage owing to the natural abundance and low cost of sodium resources. Anode materials are the key to the success of SIBs. Among various anode candidates, hard carbon (HC) is widely regarded as the most practical anode material for SIBs because of its favourable capacity (>300 mAh g-1), suitable working potential, and good compatibility with commercial electrolytes. However, despite extensive investigation, the electrochemical sodium-ion storage in HC remains controversial, particularly regarding the origin of the sloping and plateau capacities and the nature of sodium species stored in different structural domains.Here, we systematically investigate the evolution of paramagnetic species in HC during sodiation and desodiation to elucidate the sodium storage mechanism at the electronic-structure level. High-resolution electron paramagnetic resonance (EPR) spectroscopy is employed as the central characterisation tool and is complemented by in situ Raman spectroscopy, in situ synchrotron X-ray diffraction, and density functional theory (DFT) calculations. Through this combined experimental and theoretical approach, we establish a direct correlation among paramagnetic signatures, electronic-structure evolution, and electrochemical behaviour in HC.Our results reveal that two distinct but coexisting intercalation processes, namely conventional Na+ intercalation and newly discovered Na+-solvent co-intercalation, occur in HC, and that both processes are active across the sloping and plateau voltage regions. In addition to the intercalation processes, within the sloping region, we found that Na+ ions are found to be stored at in-plane Stone–Wales defect sites. We further reveal that these defect-associated storage sites undergo an unusual electronic evolution from a paramagnetic or quasi-metallic state toward the formation of metallic Na as sodiation proceeds. As studied via DFT calculations, it is found that this transition is driven by local charge redistribution within the graphene layers and provides new insight into the dynamic electronic response of disordered carbon frameworks during sodium uptake.These findings offer a deeper mechanistic understanding of sodium storage in hard carbon and clarify several long-standing debates concerning the respective contributions of Na+ intercalation, Na+-solvent co-intercalation, defect-site storage, and quasi- and metallic Na. More broadly, this work demonstrates the unique capability of EPR spectroscopy to probe charge storage processes in battery electrode materials and highlights its value as a powerful platform for mechanistic studies of complex electrochemical systems.

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Keywords: Sodium-ion batteries, anode, hard carbon



Dr Qingbing Xia received his PhD from the University of Wollongong in 2019 and has been a Research Fellow at The University of Queensland since 2020. His research focuses on advanced electrode and electrolyte materials and the mechanistic understanding of battery reactions using in situ and operando characterisation. He has published more than 60 papers in leading journals, including Advanced Materials, Angewandte Chemie, and Advanced Energy Materials. His work has attracted over 4,000 citations (h-index 32). He also serves as a reviewer and assessor for more than 30 journals and major funding agencies, including ARC, NSFC, and the European Research Council

Xiaoman Lin

Flinders University, Australia

Day 3: 14:30-14:42, Oral Talk

Title: Modulating Two-Electron Storage in Aqueous Zinc Radical Batteries

Abstract: Aqueous zinc batteries offer a safe and sustainable route for energy storage. TEMPO-based radical polymers are promising organic cathodes because of their stable redox centers, suitable redox potentials, fast redox kinetics, and tunable structures. However, most TEMPO cathodes store charge via a one-electron oxidation process, thereby limiting their capacity and energy density. Here, we design TEMPO-based polymers for aqueous zinc radical batteries and examine whether two-electron redox storage is achievable. We further investigate the role of ether-Zn^{2+} coordination in the redox process and the effect of carbon surface chemistry on reaction kinetics. By linking polymer structure to interfacial charge-transfer behavior, this work provides design guidelines for high-capacity radical polymer cathodes in aqueous zinc-organic batteries.
Keywords: aqueous zinc batteries; PGTEMPO; radical polymers; two-electron redox; carbon surface chemistry

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Zijian Cai
Queensland University of Technology, Brisbane, Queensland, Australia

Day 3: 14:42-14:54, Oral Talk

Title: Tailored highly conductive collectors through interface engineering

Abstract: Anode-free sodium metal batteries (AFSMBs) are promising for next-generation energy storage due to their high energy density and low cost. However, their practical application is still limited by the low reversibility of Na plating/stripping and uneven Na deposition on conventional Al current collectors. Herein, a thin AgBiS2 interfacial layer is fabricated on commercial Al by a simple spin-coating and annealing process to construct an AgBiS2@Al current collector. The AgBiS2 layer improves the sodiophilicity of the Al surface and promotes uniform Na nucleation and deposition. Meanwhile, the compact and continuous AgBiS2 layer helps regulate the local current distribution and suppress dendritic Na growth, leading to highly reversible Na plating/stripping and stable cycling. Benefiting from the AgBiS2-modified Al current collector, the AgBiS2@Al electrode delivers excellent electrochemical performance with stable Na plating/stripping over 2000 cycles at 3 mA cm-2 in half-cells, while symmetric cells show stable cycling for approximately 2700 h at 1 mA cm-2. Furthermore, the AgBiS2@Al ccurrent collector enables stable cycling of anode-free Na-metal batteries for over 600 cycles at 2C. This work demonstrates a simple and scalable strategy for engineering Al current collectors and provides a promising pathway toward highly reversible and high-energy-density anode-free sodium metal batteries.

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