Organic Battery Days 2025

8th Annual Conference

22-24 April 2025 | Level 14, Festival Plaza

Flinders University (City Campus)

Adelaide, Australia

Metrohm

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INSTRUMENTS

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Flinders University

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ORGANIC BATTERY DAYS 2025

Co-Hosted by

Flinders University

Queensland University of Technology

Sponsored by

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Franco-Australian Centre for Energy Transition

College of Science and Engineering, Flinders University

Centre for Material Science, Queensland University of Technology

WELCOME ADDRESS

Dear OBD families,

The OBD meeting is a platform for scientists to highlight crucial advancements in organic energy storage. Since its inaugural meeting in 2017 in Uppsala, Sweden, the OBD meeting has become an iconic event for the community to share their ideas, showcase their findings, and foster collaborations in finding innovative solutions for more sustainable energy storage.

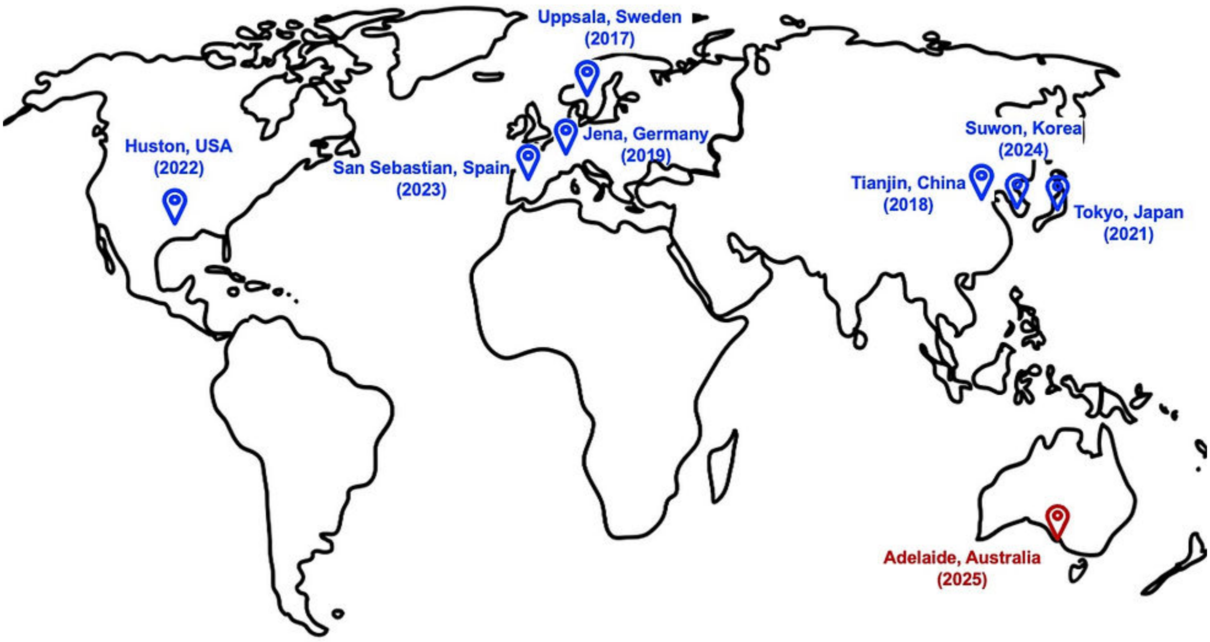
The 8th OBD meeting is co-hosted by Flinders University and Queensland University of Technology. The conference will be held at Flinders University, City Campus in Adelaide, Australia, on 22-24 April 2025. This is the first time for the South Hemisphere to host the OBD meeting. We welcome you to the largest island on the earth, discussing intriguing science and exploring amazing nature.

Sincerely

Zhongfan Jia & James Blinco

OBD2025 Chair

OBD HISTORY


Uppsala, Sweden (2017)
Huston, USA (2022)
San Sebastian, Spain (2023)
Jena, Germany (2019)
Suwon, Korea (2024)
Tianjin, China (2018)
Tokyo, Japan (2021)
Adelaide, Australia (2025)


ORGANIC
BATTERY DAYS
8-9 June 2017, Uppsala, Sweden


ORGANIC
BATTERY DAYS
13-15 JUNE 2018 NANKAI UNIVERSITY, TIANJIN, CHINA


ORGANIC
BATTERY
DAYS 2019
3 - 5 June 2019
Friedrich Schiller University Jena
Jena, Germany


Organic Battery Days 2021
To be held on 25-28th November, 2021
Online (Tokyo)


ORGANIC
BATTERY DAYS
Oct. 13-14, 2022, Houston, Texas
https://orgabattdays.ece.uh.edu/


OBD-2023
San Sebastián (Spain)


Organic Battery Days 2024
The 7th Organic Battery Days Meeting
19 ~ 21 June, 2024
Samsung Library Auditorium (SKKU) Suwon, Republic of Korea

COMMITTEES

Conference chairs

A/Prof Zhongfan Jia (Flinders University)

A/Prof James Blinco (Queensland University of Technology)

Local organization committee

A/Prof Zhongfan Jia (Flinders University)

A/Prof James Blinco (Queensland University of Technology)

Prof Michelle Coote (Flinders University)

Prof Justin Chalker (Flinders University)

Prof Maria Forsyth (Deakin University)

Dr Dong Jun Kim (University of New South Wales)

Dr Thomas Nicholls (Flinders University)

International Advisor Committee

Prof. Matthieu Becuwe (Universite de Picardie Jules Verne, France)

Prof. Daniel Brandell (Uppsala University, Sweden)

Prof. Jun Chen (Nankai University, China)

Dr. Ji Eon Kwon (Korea Institute of Science and Technology, Korea)

Prof. Jodie Lutkenhaus (Texas A&M University, USA)

Prof. David Mecerreyes (POLYMAT Institute, Spain)

Prof. Kenichi Oyaizu (Waseda University, Japan)

Prof. Ho Seok Park (Sungkyunkwan University, Korea)

Prof. Philippe Poizot (Universite de Nantes, France)

Prof. Ulrich S. Schubert (Friedrich Schiller University Jena, Germany)

Dr. Masaru Yao (AIST, Japan)

Prof. Yan Yao (University of Houston, USA)

Dr. Wei Wang (Pacific Northwest National Laboratory, USA)

4|8 Series

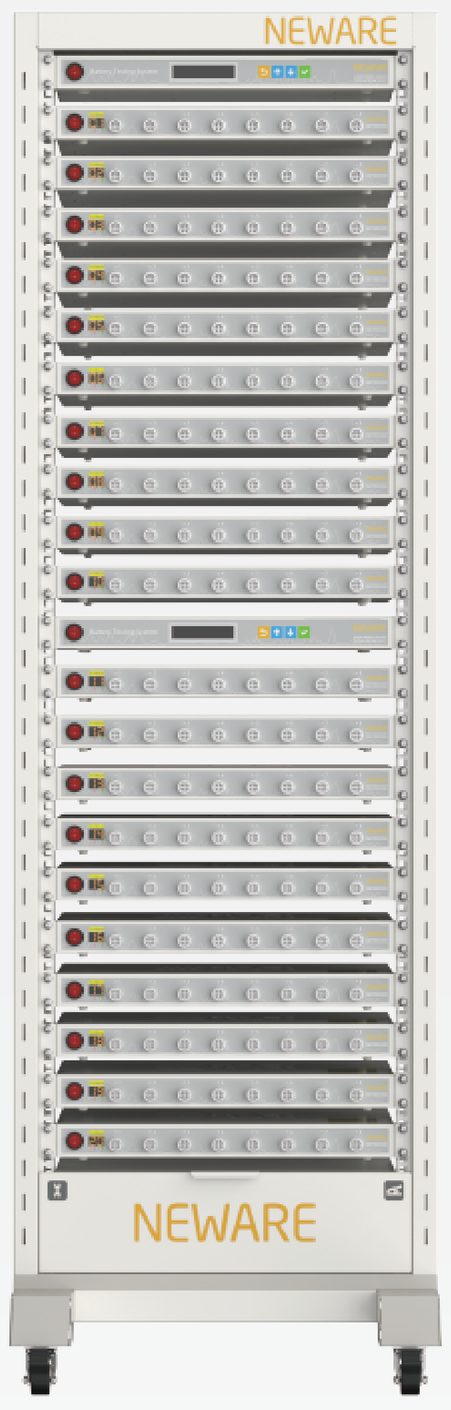
Precision empowers confidence.

The 4/8 Series battery testing system is specifically designed for battery material research and 3C battery testing and development. In addition to standard charging / discharging test functions, it also integrates various testing functions such as EIS, DCIR, CV, and pulse simulation, meeting comprehensive testing needs.

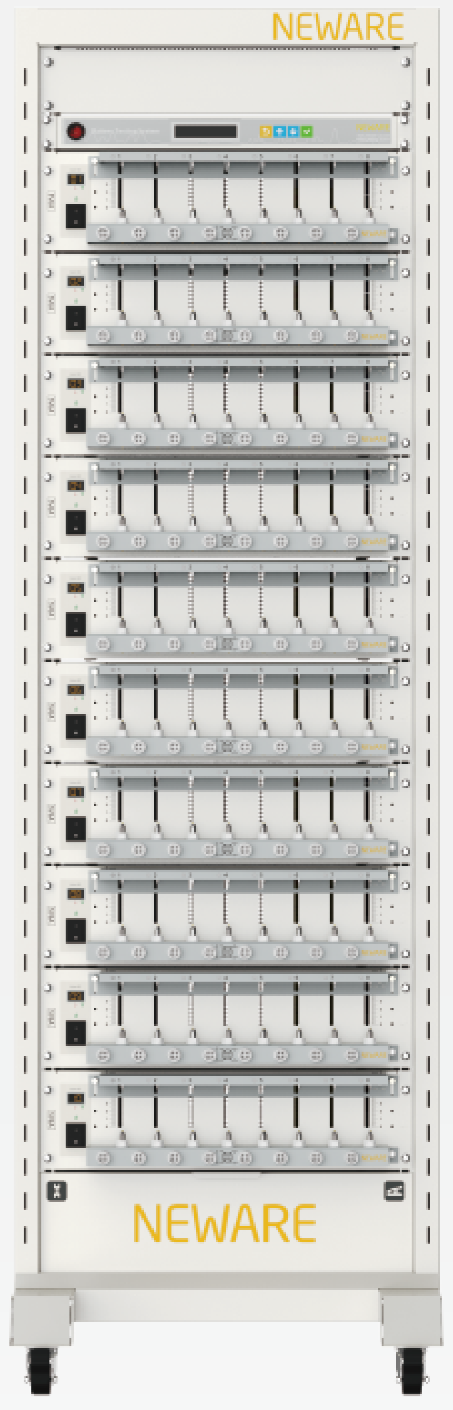
CT/CE-4000 Series
Scan to learn more details

CT/CE-8000 Series
Scan to learn more details

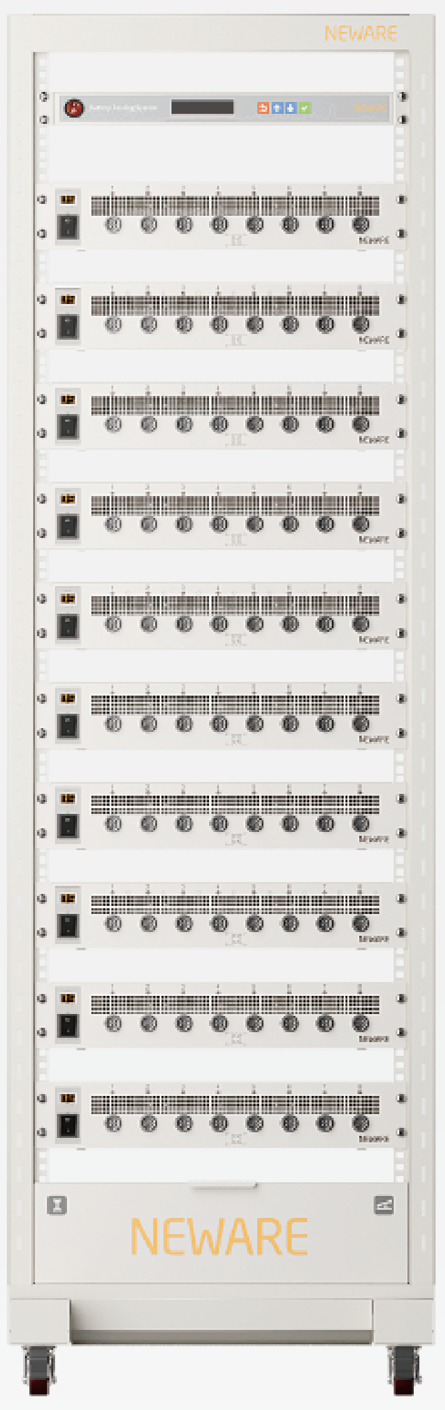
CT-8002Q-5V100mA-124
- Size: 127×225×48mm



CT-4008Q-5V100mA-124
- Single: 19"1U (483×310×48mm)
- Overall: 555×650×1832mm



CT-4008Q-5V6A-S1
- Single: 19"3U (483×404×130mm)
- Overall: 555×650×1832mm



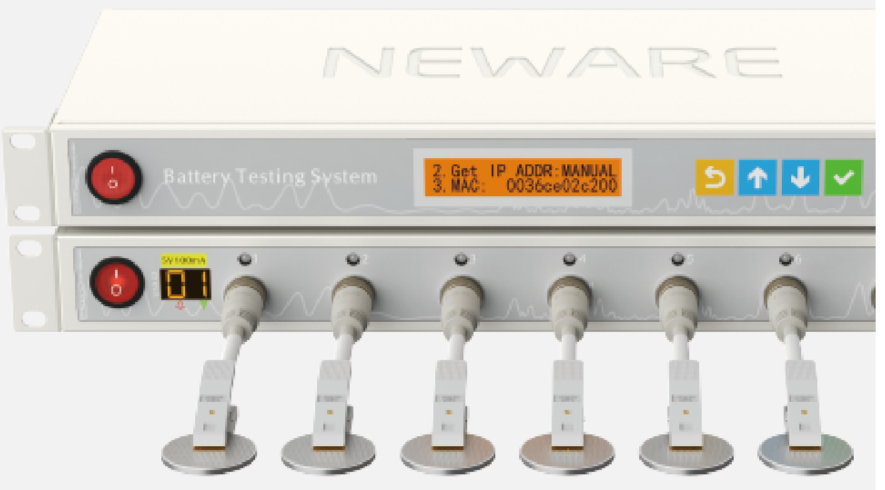
CE-4008Q-5V20A-SR
- Single: 19"2U (483×337×88.5mm)
- Overall: 555×650×1832mm

Battery Testing System	Voltage	Current
CT-4000 & CT-8000 mA Battery Testing System	5V	10mA/20mA/50mA/100mA
CT/CE-4000 & CT/CE-8000 3C Battery Testing System	5V	6A/12A/15A/20A/30A

Multi-range, more precise.

The 4/8 series battery testing system has a current range of 3 scales / 4 scales.

5V100mA
- 0.2μA ~ 0.1mA
- 0.1mA ~ 1mA
- 1mA ~ 10mA
- 10mA ~ 100mA



CT-4008Q-5V100mA-124

Multiple current options, meeting diverse needs.

5V10mA/20mA/50mA/100mA
Designed for coin cell testing.

5V6A/12A/15A/20A/30A
Designed for 3C battery testing.

CT-4008Q-5V6A-S1

Comprehensive testing.

Cycle Life Test

Rate Charging / Discharging Test

GITT
GITT Test

DCIR
DCIR Test

dQ/dV
Differential Capacity Curve

Pulse Test

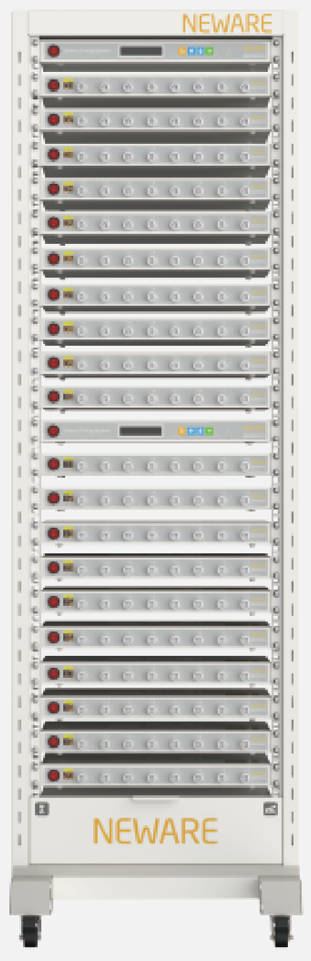
Battery temperature test.

Linked with environmental test chambers, it achieves battery temperature performance testing and conducts comprehensive performance evaluation.

Constant Temperature Test

Thermal Condition Test

WHW-200L



CT-4008Q-5V100mA-124

Voltage & Current Accuracy
±0.01%/0.02%/0.05%F.S.

Current Response Time
(10%F.S.~90%F.S.)
≤1/1.5/2ms

Recording Frequency
10 /100/1000Hz

Sampling Time
10/100ms

Enhanced features, revolutionary experience.

Portable battery testing device with a Type-C power supply interface, featuring EIS, CV, and other testing functions.

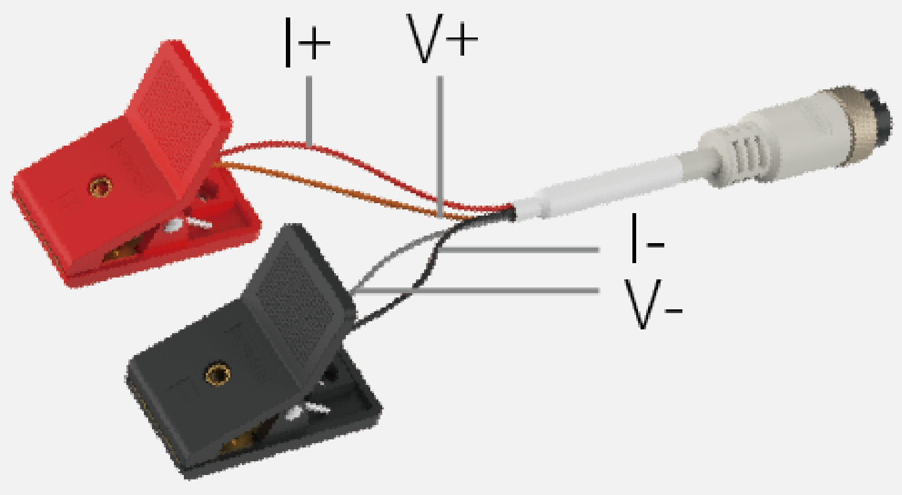
CV Test

EIS Test

CT-8002Q-5V100mA-124

Four-wire connection.

Four-wire test leads reduce the impact of lead resistance and improve measurement accuracy.



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*CT/CE: Battery charging-discharging test system. "E" indicates that this equipment is equipped with energy feedback function.
*Other models can be customized according to voltage and current requirements.
*Actual dimensions may differ from those marked in the picture. Please refer to the actual product for the correct size.

WHW/WGDW
Environmental Test Chamber Series

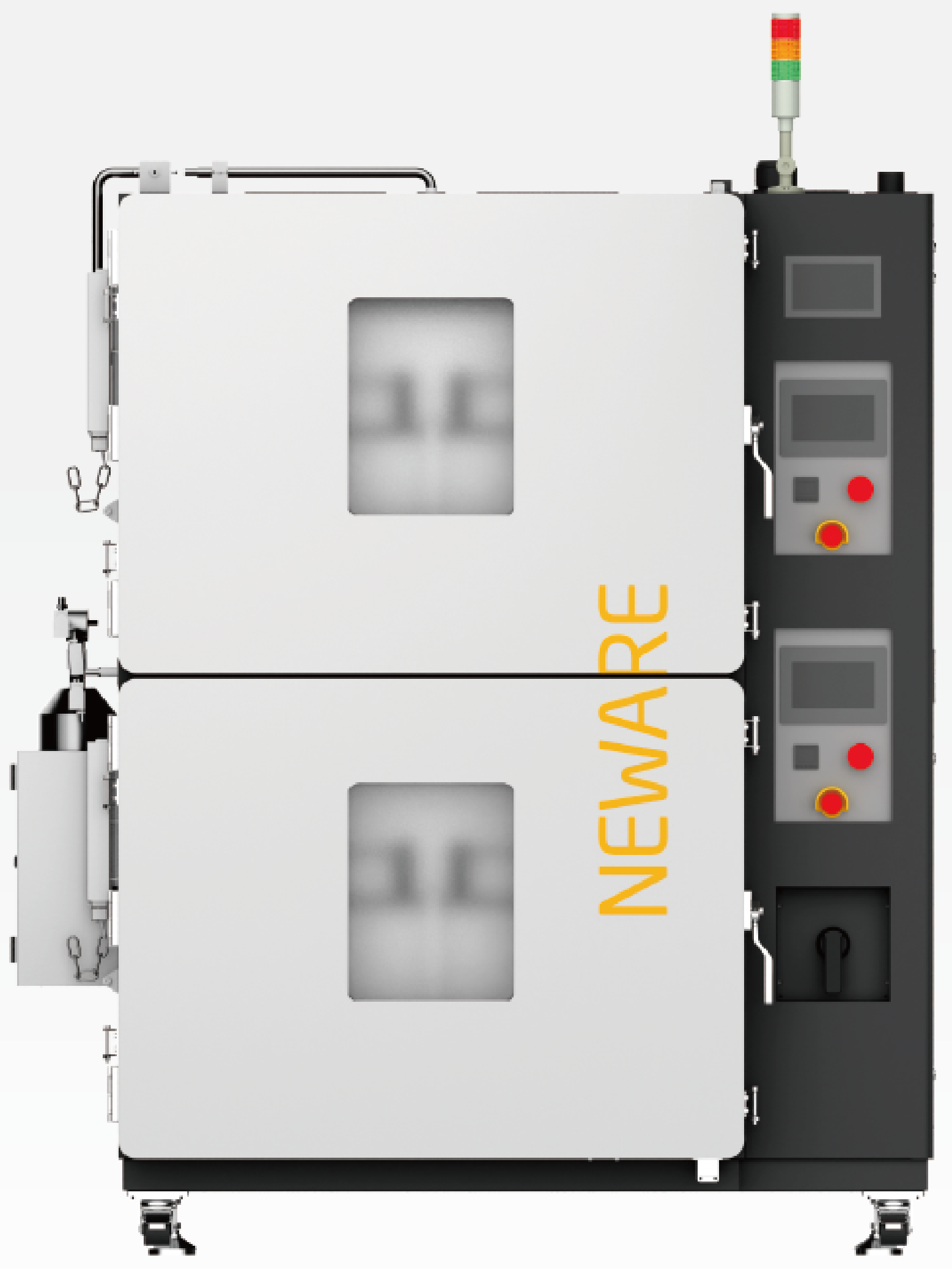
Silent insulation, loud on performance.

Environmental test chambers offer a stable environment for constant, high, and low-temperature testing of battery temperature performance. They reveal the performance characteristics of battery materials at various temperatures, assess battery performance under extreme heat or cold, and ensure safety during temperature shock tests.

Environmental Test Chamber
Scan to learn more details

WHW-200L-160CH-B
- Size: 600x920x1800mm
- Weight: Approx.200kg

WHW-100L-2-160CH
- Size: 600x920x1920mm
- Weight: Approx.260kg



WGDW-380L-2-40BFC-5V600A8CH
- Size: 1600x1800x2050mm
- Weight: Approx.900kg

Testing System	Nominal Capacity	Temperature Range
WHW Constant Temperature Test Chamber Series	25L, 100L, 200L, 400L	15°C～60°C
		0°C～60°C
WGDW High-Low Temperature Test Chamber Series	100L, 200L, 400L, 600L, 800L	-20°C～150 °C
		-40°C～150 °C
		-70°C～150°C

All-in-One Testing System series.

The battery testing system integrates with the environmental test chamber, saving experimental space.

Voltage & Current Accuracy	Current Response Time	Recording Frequency	Sampling Time
±0.01%/0.05%F.S.	10/100Hz	(10%F.S.～90%F.S.) ⩽1ms	10/100ms

- Temperature Deviation ±2°C (No Load & Stable Temperature)
- Temperature Fluctuation ⩽0.5°C (No Load & Stable Temperature)
- Thermal Condition Test
- High and Low Temperature Testing
- Constant Temperature Test
- Forced Circulation Air Cooling

Multi-zone temperature design.

Dual-zone/-multi-zone design with independent control of each zone to increase testing efficiency.

(Single)
WHW-25L-S-16CH
- Size: 440x580x410mm
- Weight: Approx.45kg

Dedicated accessories.

Exclusive fixtures and accessories for environmental test chambers provide comprehensive support to ensure a worry-free testing process.

WGDW-380L-2-40BFC-5V600A8CH

WHW-200L-5V12A64CH

*WHW/WGDW: Constant Temperature Chamber/High-Low Temperature Chamber
*All-in-One Testing System can be customized according to voltage and current requirements.
*Actual dimensions may differ from those marked in the picture. Please refer to the actual product for the correct size.

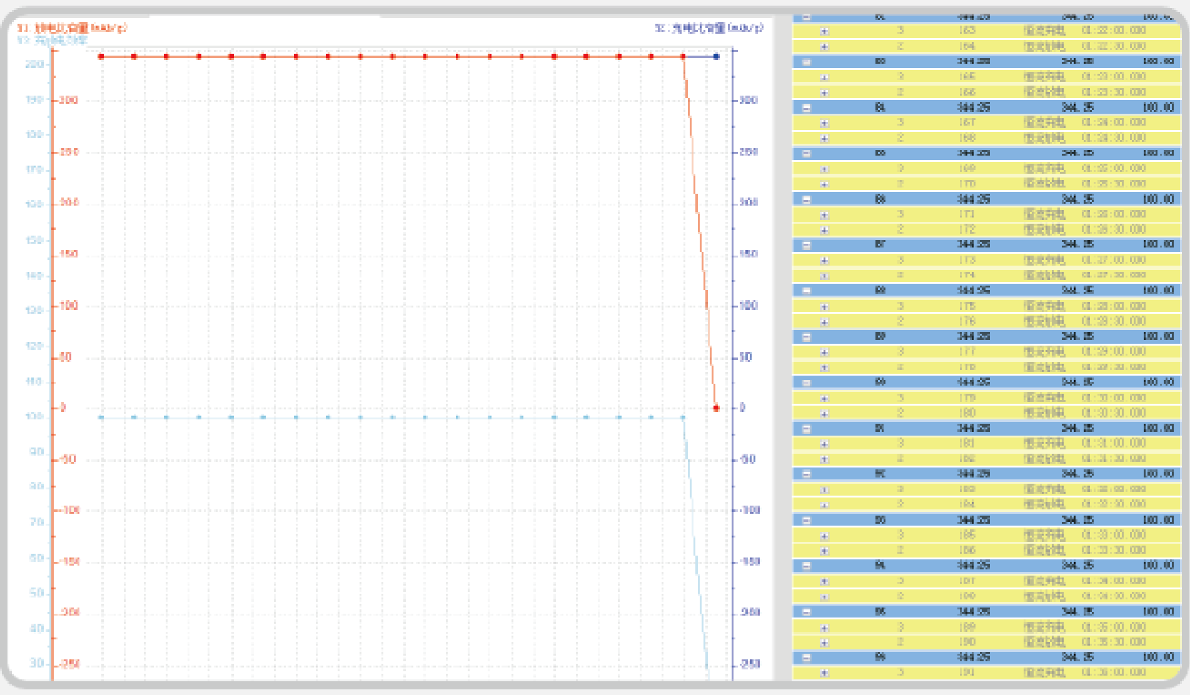
NEWARE
Since 1998

BTS8.1 / BTS9.0

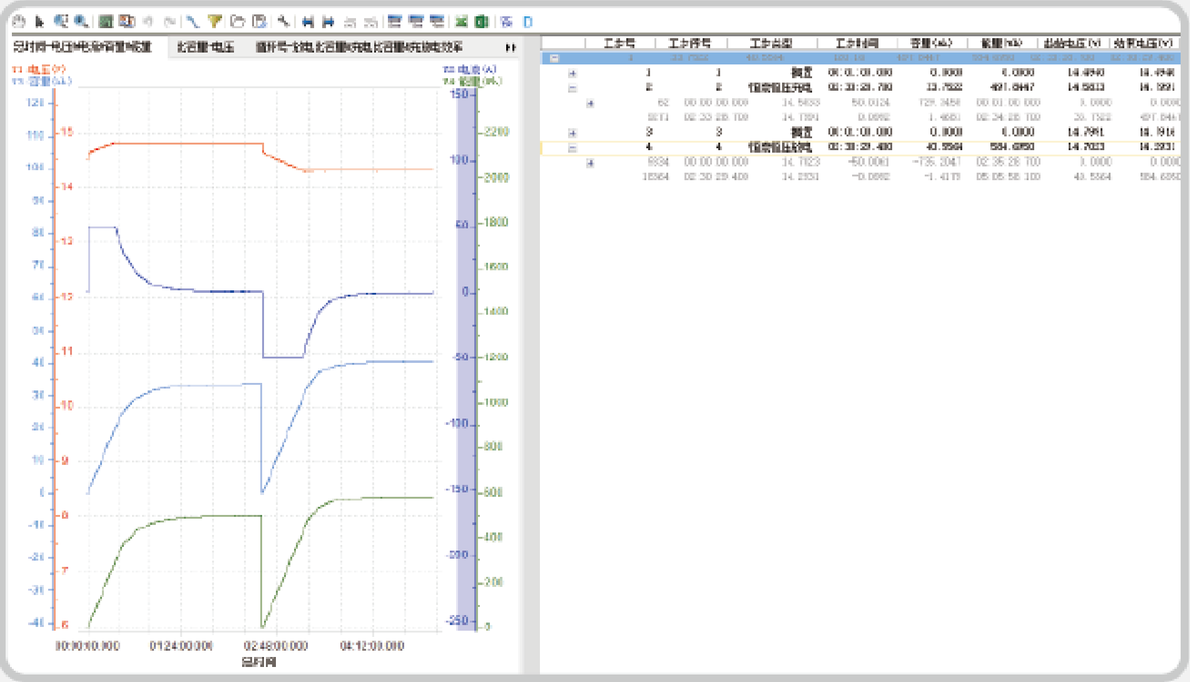
Hardware defines precision, software forges the future.

Scan to download
BTS software

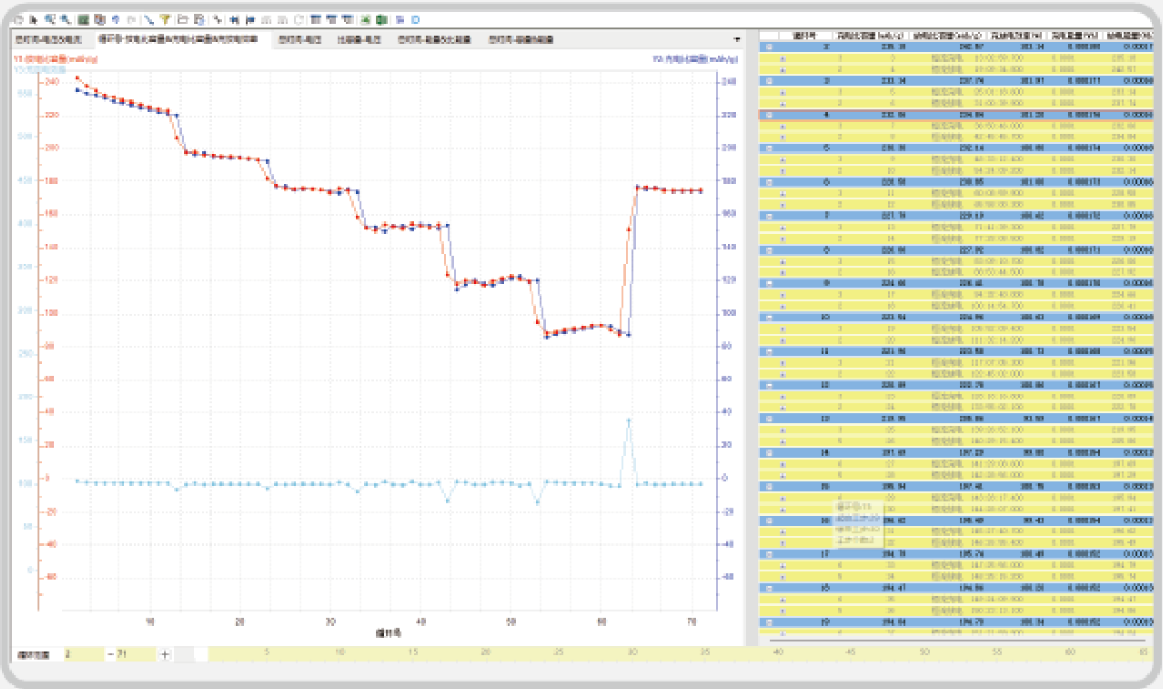
Charging / Discharging Test



Cycle life test

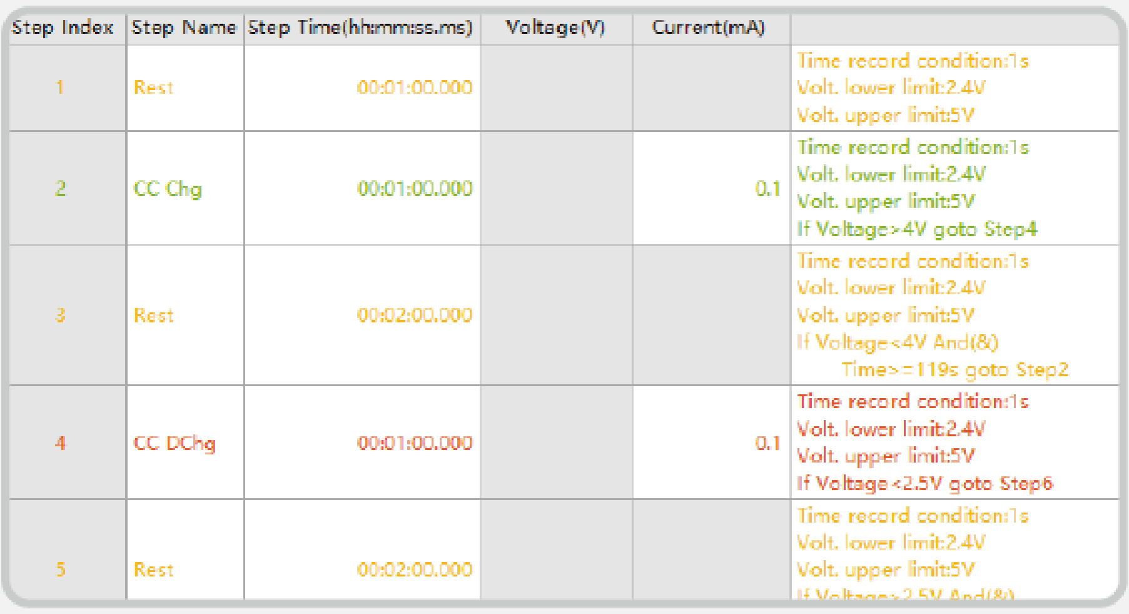


CCCV test



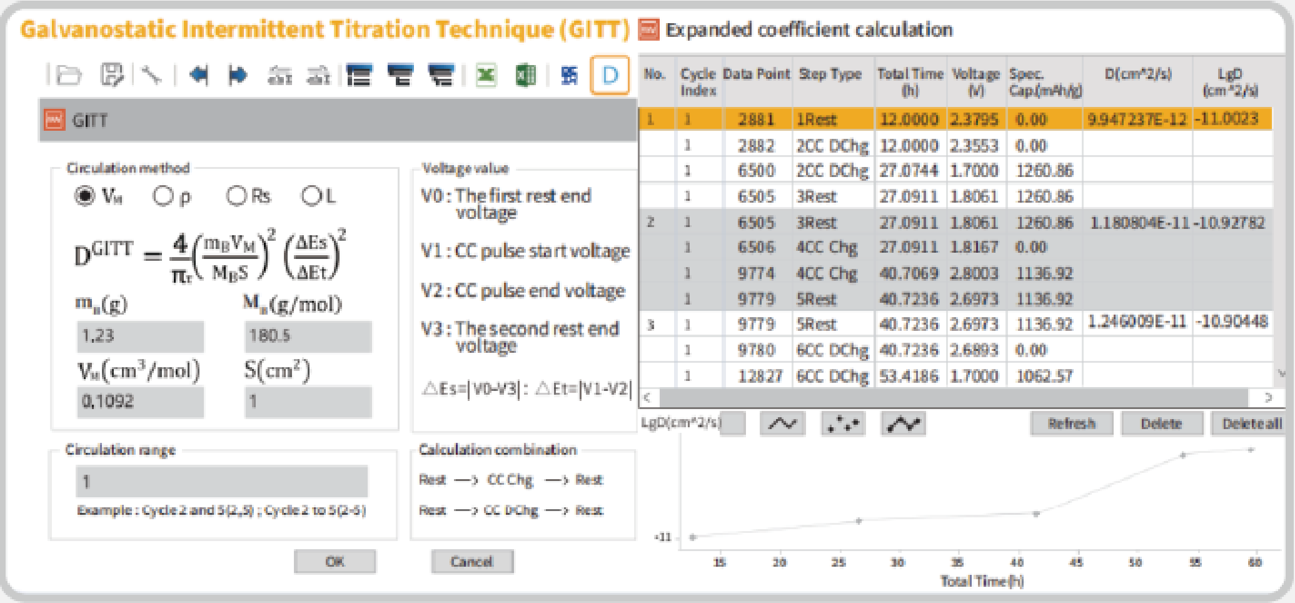
Rate test

Galvanostatic Intermittent Titration Technique (GITT)



Step Index	Step Name	Step Time(hh:mm:ss.ms)	Voltage(V)	Current(mA)	
1	Rest	00:01:00.000			Time record condition:1s Volt. lower limit:2.4V Volt. upper limit:5V
2	CC Chg	00:01:00.000		0.1	Time record condition:1s Volt. lower limit:2.4V Volt. upper limit:5V If Voltage>4V goto Step4
3	Rest	00:02:00.000			Time record condition:1s Volt. lower limit:2.4V Volt. upper limit:5V If Voltage<4V And(&) Time>=119s goto Step2
4	CC DChg	00:01:00.000		0.1	Time record condition:1s Volt. lower limit:2.4V Volt. upper limit:5V If Voltage<2.5V goto Step6
5	Rest	00:02:00.000			Time record condition:1s Volt. lower limit:2.4V Volt. upper limit:5V If Voltage>2.5V And(&)

Diffusivity(D) calculation



Galvanostatic Intermittent Titration Technique (GITT)

Expanded coefficient calculation

GITT

Circulation method

● V_M ○ ρ ○ Rs ○ L

$$D^{GITT}=\frac{4}{\pi\tau}\left(\frac{m_B V_M}{M_B S}\right)^2\left(\frac{\Delta E_s}{\Delta E_t}\right)^2$$

m_B(g): 1.23
M_B(g/mol): 180.5
V_M(cm^3/mol): 0.1092
S(cm^2): 1

Voltage value

V0 : The first rest end voltage
V1 : CC pulse start voltage
V2 : CC pulse end voltage
V3 : The second rest end voltage
△Es=|V0-V3| : △Et=|V1-V2|

Circulation range

1

Example : Cycle 2 and 5(2,5) ; Cycle 2 to 5(2-5)

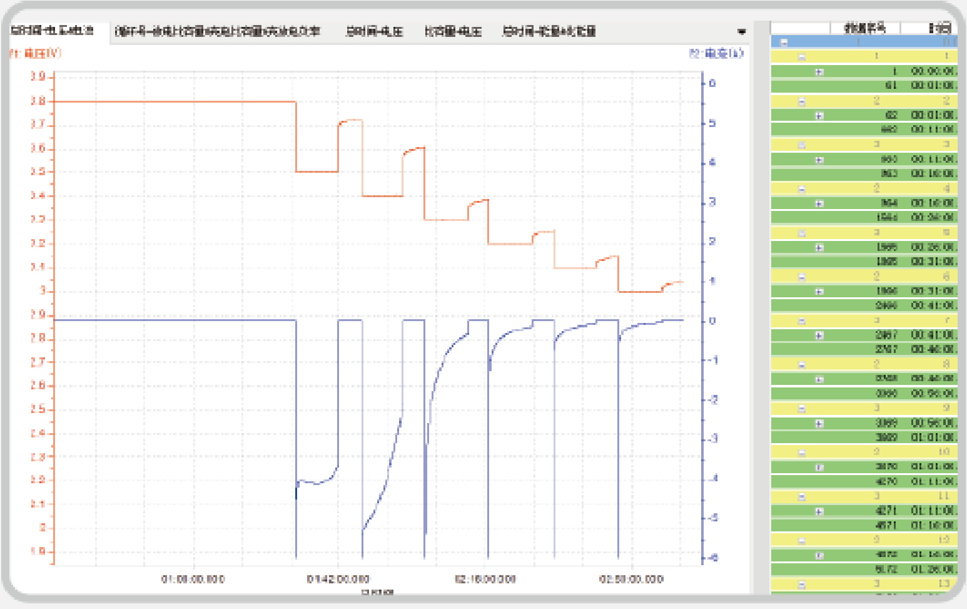
Calculation combination

Rest —> CC Chg —> Rest
Rest —> CC DChg —> Rest

No.	Cycle Index	Data Point	Step Type	Total Time (h)	Voltage (V)	Spec. Cap.(mAh/g)	D(cm^2/s)	LgD (cm^2/s)
1	1	2881	1Rest	12.0000	2.3795	0.00	9.947237E-12	-11.0023
	1	2882	2CC DChg	12.0000	2.3553	0.00		
	1	6500	2CC DChg	27.0744	1.7000	1260.86		
	1	6505	3Rest	27.0911	1.8061	1260.86		
2	1	6505	3Rest	27.0911	1.8061	1260.86	1.180804E-11	-10.92782
	1	6506	4CC Chg	27.0911	1.8167	0.00		
	1	9774	4CC Chg	40.7069	2.8003	1136.92		
	1	9779	5Rest	40.7236	2.6973	1136.92		
3	1	9779	5Rest	40.7236	2.6973	1136.92	1.246009E-11	-10.90448
	1	9780	6CC DChg	40.7236	2.6893	0.00		
	1	12827	6CC DChg	53.4186	1.7000	1062.57		

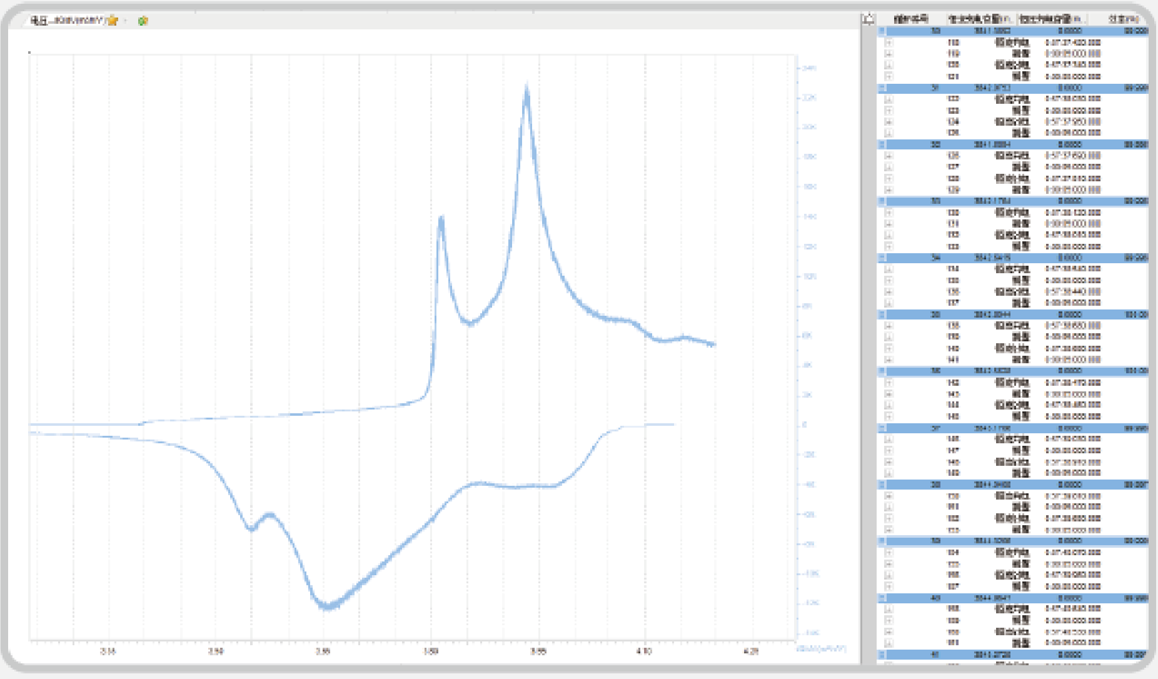
Diffusivity(D) calculation

Potentiostatic Intermittent Titration Technique (PITT)



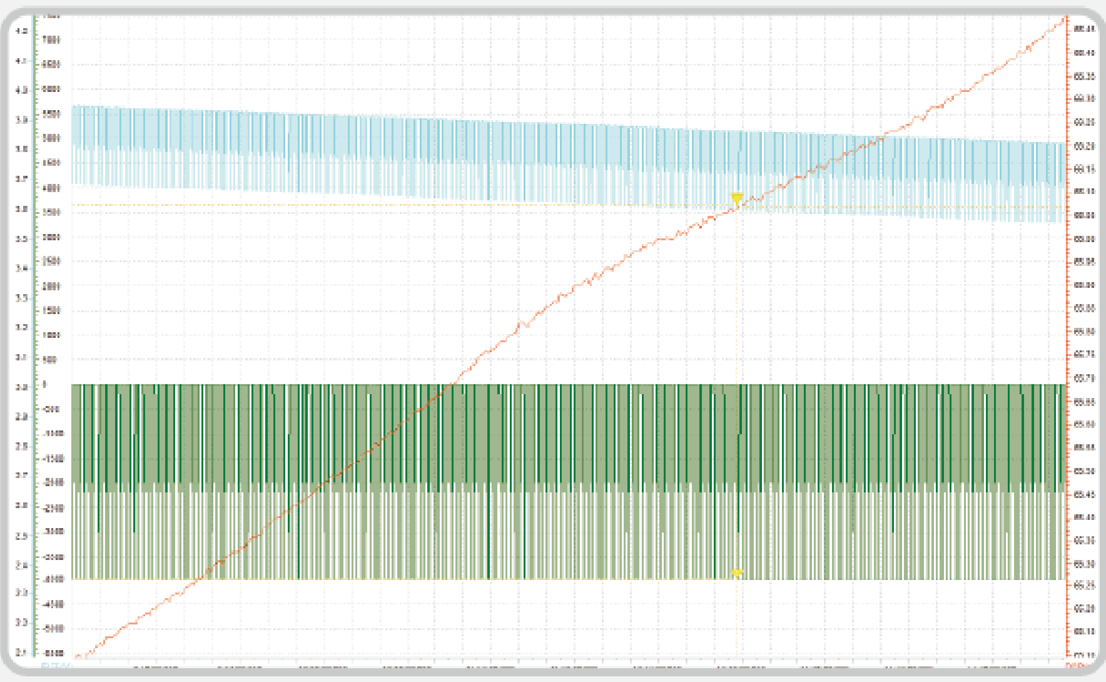
PITT test

Incremental Capacity Analysis (ICA)



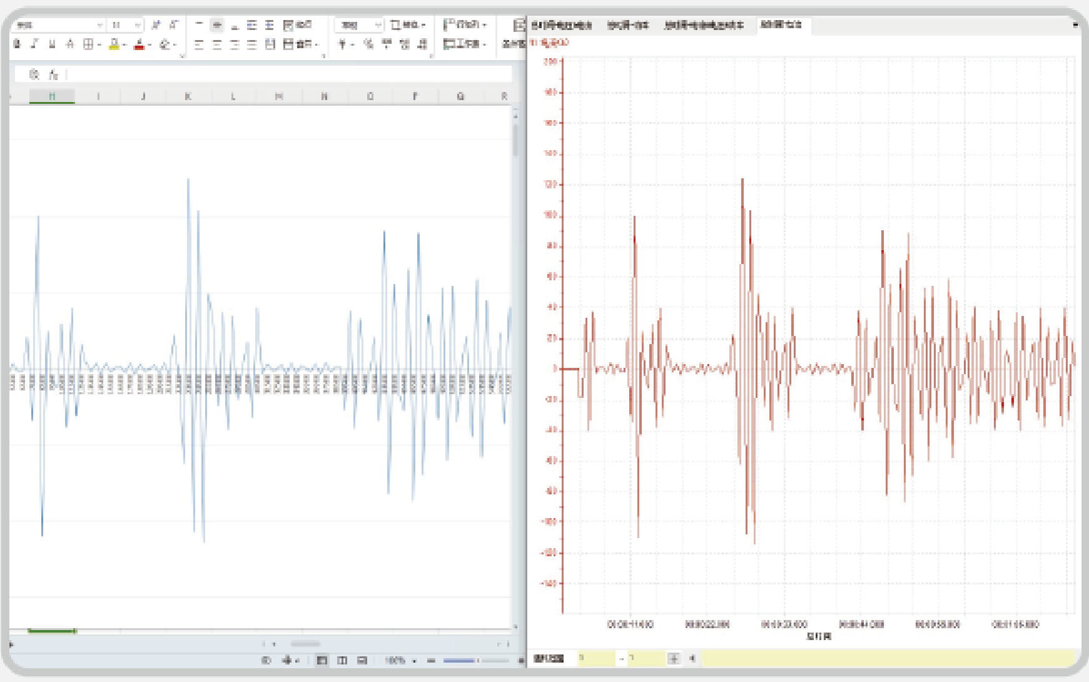
Differential capacity curve (dQ/dV)

DC Internal Resistance (DCIR)



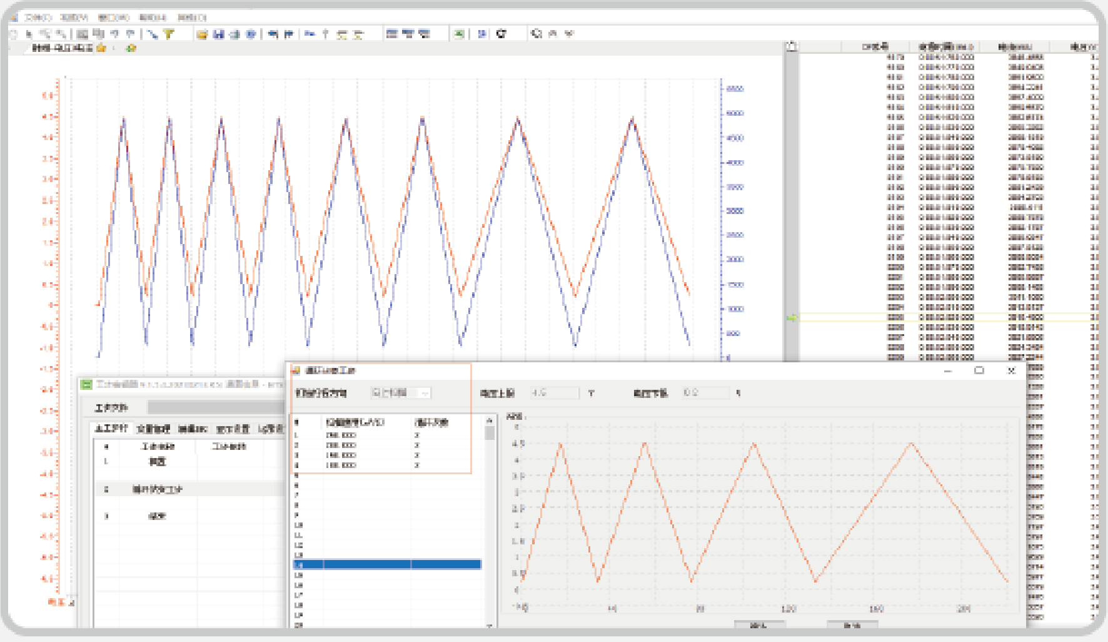
DCIR-potential & current

Simulation Test

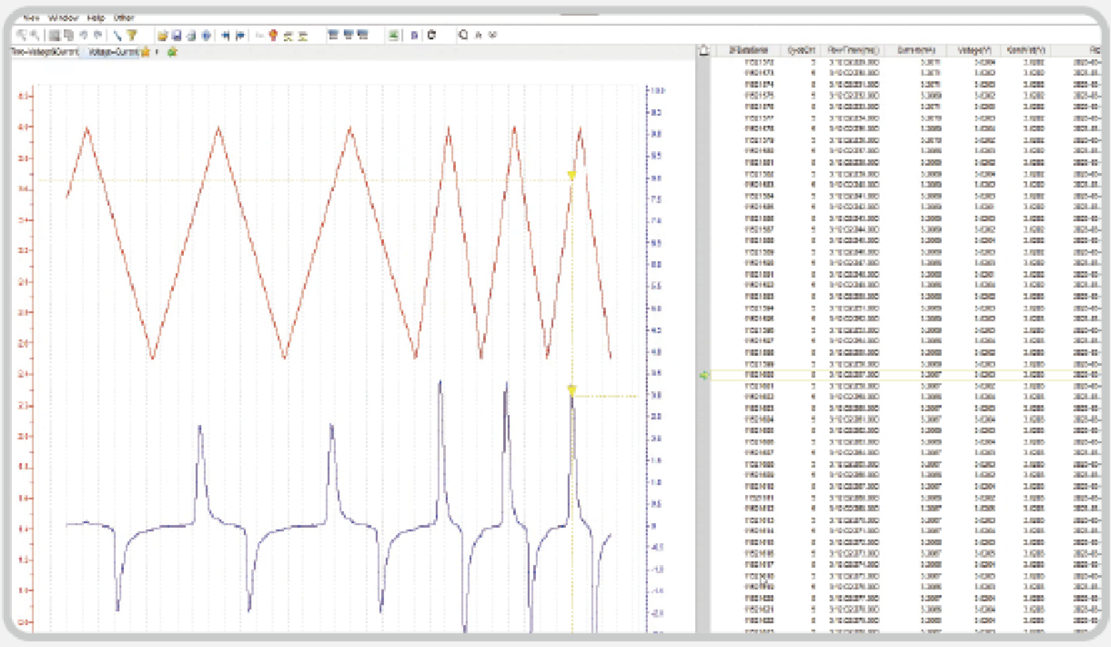


Pulse width 100ms

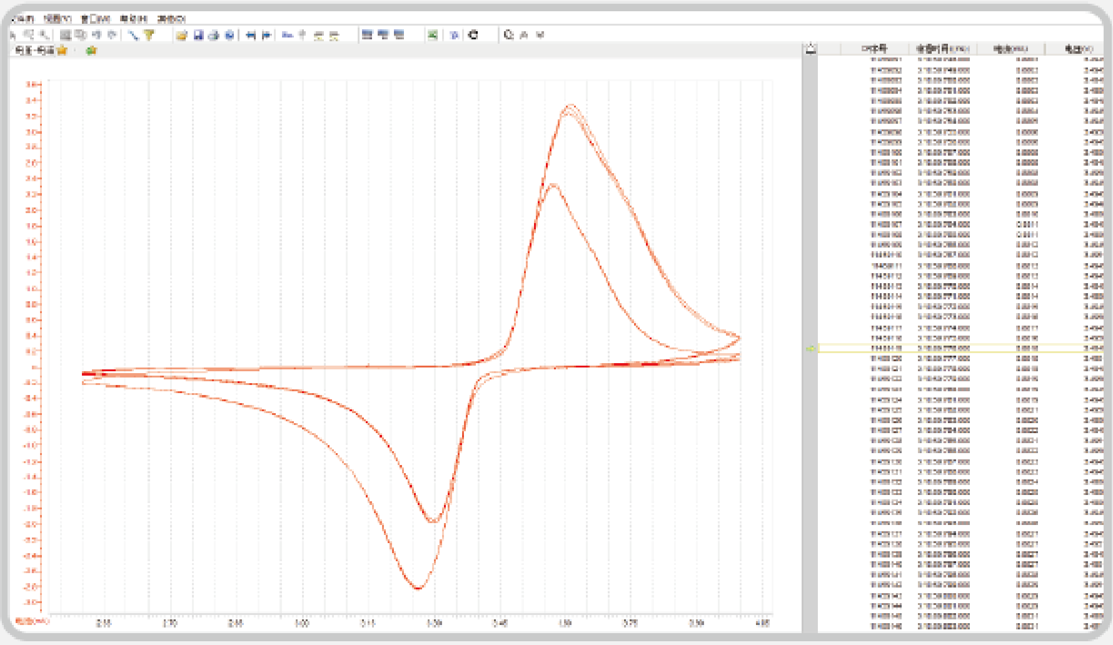
Cyclic Voltammetry (CV)



Test procedure



Time-potential & current



Potential-current curve

Wherever you are, support is always near.

We're dedicated to the excellence of our equipment and the extensive coverage of our global support services, ready to provide prompt assistance for all battery cycler challenges.

We offer adaptable production to meet unique specifications, and for further enlightenment, our neware.net database is a treasure trove of informative articles, technical insights, and BTS tutorials.

Quick Start Guide

BTS Tutorials

FAQ

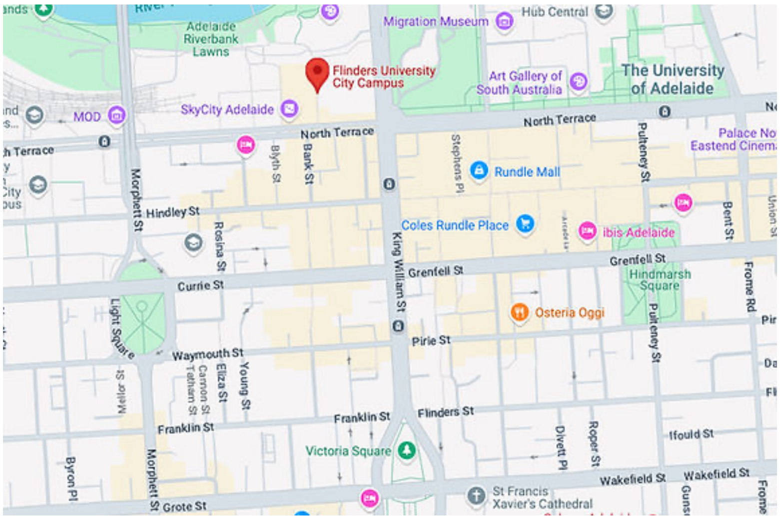
Website: www.neware.net
Code: S02-002-CPML
Version Number: ZY-EN-241108-V3.0

Scan to browse the e-manual

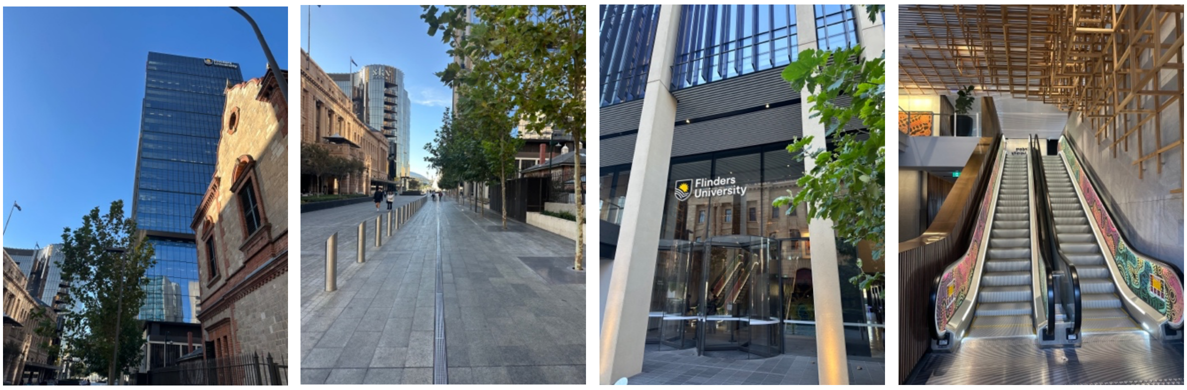
CONFERENCE VENUE

Level 14, Festival Tower

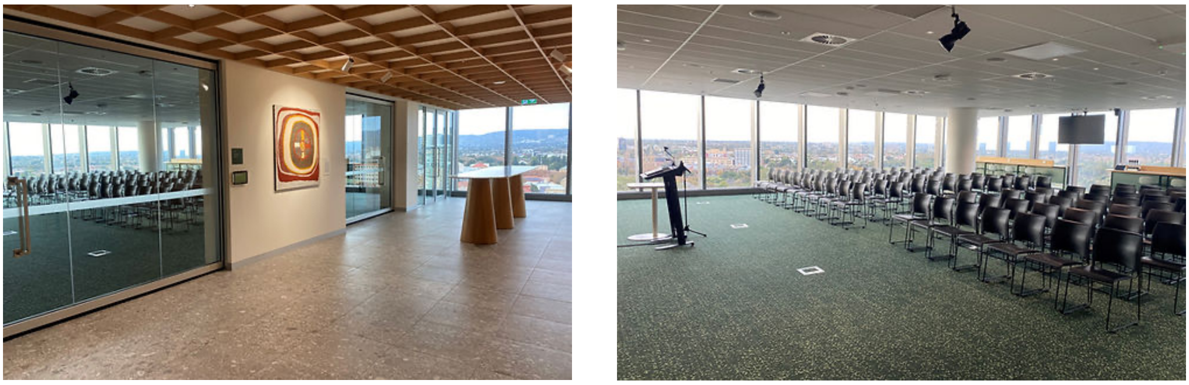
Flinders University, City Campus



Entrance



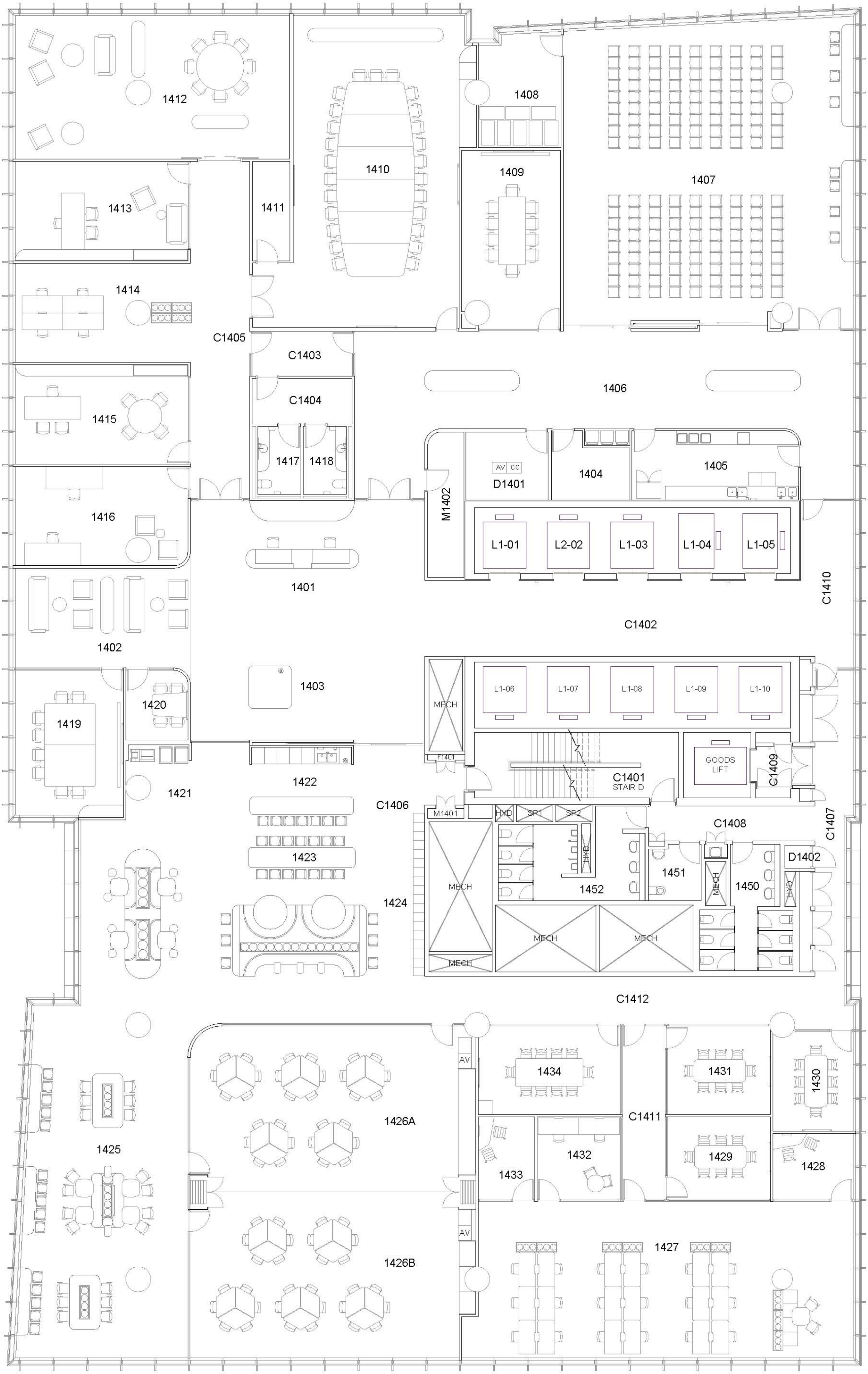
Level 14 (Access by lift; volunteers will swipe the card for your access)



Address: Festival Tower, Station Rd, Adelaide, SA 5000

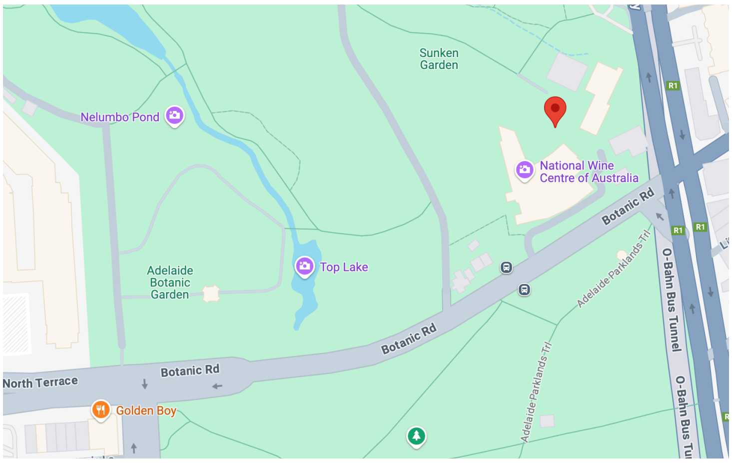
Contact: Zhongfan Jia **Mobile**: +61-422271431

Level 14 floor plan

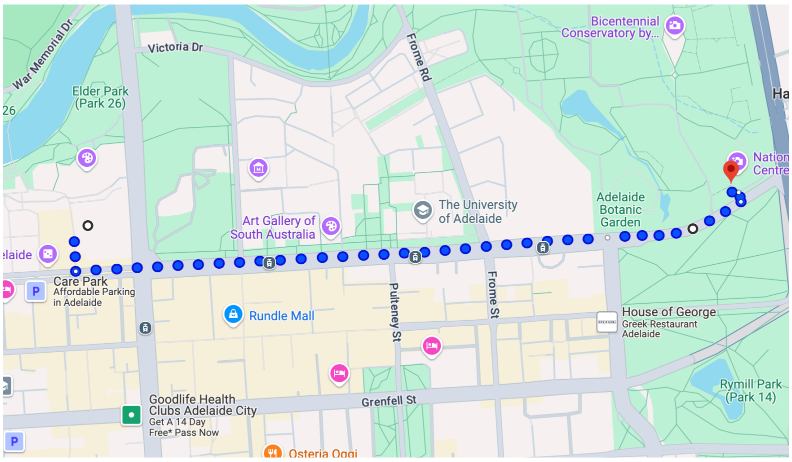


CONFERENCE DINNER VENUE

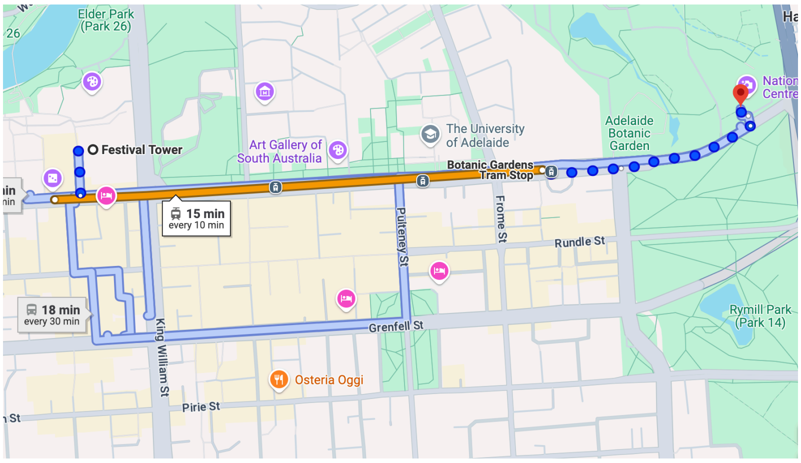
National Wine Centre of Australia



Walking from Festival Tower along North Terrace (23 min, 1.6 km, passing Adelaide University, **recommended**)



Or take the tram (three stops, free) and then walk (Total 15 min)



The 8th Organic Battery Days (OBD2025) International Conference Full Program
22nd-24th April 2025 Festival Plaza, Flinders University, City Campus

Plenary (40 min), Invited (25 min), Oral (15 min) (incl. Q&A)

Day 1: Tuesday 22nd April 2025

8:00-8:30	REGISTRATION	
	CONFERENCE OPENING	
	WELCOME NOTES	
8:40	**A/Prof Zhongfan Jia**	
	Conference co-Chair	
	Flinders University	
	OPENING REMARKS	Chair A/Prof Zhongfan Jia
8:50	**Prof Alistair Rendell**	
	Vice-President and Executive Dean	
	Flinders University	
	PLENARY LECTURE	Chair A/Prof James Blinco
9:00	**Prof Ho Seok Park**	
	Sungkyunkwan University (South Korea)	
	Electrolyte and Interfacial Engineering for Aqueous Zn Metal Batteries	
	INVITED LECTURE	
9:40	**Asst Prof Guiomar Hernández**	
	Uppsala University (Sweden)	
	Fluorine-Free Poly(vinylphenothiazine)-based Batteries with Solid Polymer Electrolytes	
10:05	**Prof Kenichi Oyaizu**	
	Waseda University (Japan)	
	High-density Lithium Sulfur Batteries with Polymeric Sulfur Electrodes	
10:30	**Dr Dong Jun Kim**	
	University of New South Wales (Australia)	
	Wiring Proton Gradients for Energy Conversion Using Light-Switchable Molecular Switches	
10:55	MORNING TEA	
	INVITED LECTURE	Chair Dr Dong Jun Kim
11:20	**Dr Klemen Pirnat**	
	National Institute of Chemistry (Slovenia)	
	High Energy Organic Cathodes for Lithium and Zinc	

11:45	**Asst Prof Nara Kim**	Chair Dr Dong Jun Kim
	Linköping University (Sweden)	
	Stretchable Organic Redox Diffusion Battery for Wearable Power Source	
	CONTRIBUTED LECTURE	
12:10	**Clara Zens**	
	Friedrich Schiller University Jena (Germany)	
	Charge transfer and storage in novel materials for organic radical batteries	
12:25	**Saki Fukuma**	
	National Institute of Advanced Industrial Science and Technology (Japan)	
	Development of long-life and recyclable anthraquinone-based cathode carrying amide bonds	
12:40	LUNCH+POSTER	
	INVITED LECTURE	Chair Prof Cyrille Boyer
1:30	**Prof Amanda Ellis**	
	University of Melbourne (Australia)	
	Creating a Super Anode for Lithium-ion Batteries	
1:55	**Dr Shaojian Zhang**	
	Adelaide University (Australia)	
	Advanced aqueous zinc-iodine batteries for energy storage	
2:20	**Assoc Prof Kai Zhang**	
	Zhejiang University of Science and Technology (China)	
	Water Unlocks New Redox Pathways in Organic Cathode Batteries	
	CONTRIBUTED LECTURE	
2:45	**Yiqing Wang**	
	University of Queensland (Australia)	
	Self-assembled fluoropolymer gel electrolytes for ultra-stable aqueous zinc-ion battery	
3:00	**Valerio Galli**	
	Istituto Italiano di Tecnologia (Italy)	
	Edible Rechargeable Batteries	

3:15	AFTERNOON TEA + POSTER	
	INVITED LECTURE	Chair Prof Amanda Ellis/Prof Luke Henderson
3:40	**Dr Masaru Yao**	
	National Institute of Advanced Industrial Science and Technology (Japan)	
	Quinone-based Lightweight Organic Rechargeable Batteries: Analysis for Working Mechanism, and Oligomerization for Long Cycle-life	
4:05	**Dr Ji Eon Kwon**	
	Korea Institute of Science and Technology (South Korea)	
	In situ Electrochemical Crosslinking Enables High-Rate Performance of Organic Electrodes through Self-Nanostructuring	
	CONTRIBUTED LECTURE	
4:30	**Ryota Akai**	
	Tohoku University (Japan)	
	Rechargeable Aqueous MOF–Manganese Batteries	
4:45	**Robert Markowski**	
	Université catholique de Louvain (Belgium)	
	Unlocking 4V-Class N-Type Organic Cathodes: The Potential of Conjugated Triflimides and Cyanamides	
5:00	**Shuntaro Miyakawa**	
	SoftBank (Japan)	
	Charge-discharge mechanism analysis of a high-capacity organic cathode material: phenazinetetrone	
5:15-5:45	POSTER DISCUSSION	
6:00-9:30	CONFERENCE DINNER	Room
	Venue: National Wine Center of Australia	
6:20	Client access: Please arrive between 6:20-6:30	Terrace
6:30-7:00	Conference drinks with canapes	
7:00-9:30	Dinner	The Vines Room
9:30	Start departure	

The 8th Organic Battery Days (OBD2025) International Conference Full Program
22nd-24th April 2025 Festival Plaza, Flinders University, City Campus

Day 2: Wednesday 23rd April 2025

8:30-9:00	REGISTRATION	
	PLENARY LECTURE	Chair Prof Justin Chalker
9:00	**Prof Hirofumi Yoshikawa**	
	Kwansei Gakuin University (Japan)	
	Porous Framework Materials such as MOFs, COFs, and HOFs with Redox-Active Units as Cathodes in Lithium- and Sodium-Ion Batteries	
	INVITED LECTURE	
9:40	**Prof Pingan Song**	
	University of Southern Queensland (Australia)	
	Flexible Thermally Conductive Polymer Nanocomposites Films for Effective Battery Thermal Management	
10:05	**Prof Hye Ryung Byon**	
	Korea Advanced Institute of Science & Technology (South Korea)	
	Stable and Fast Redox Fe-Complex Negolytes for Near-Neutral Aqueous Redox Flow Batteries	
10:30	**Dr Xiaodan Huang**	
	University of Queensland (Australia)	
	Enabling Rechargeable Aluminium-Organic Batteries	
10:55	MORNING TEA	
	INVITEDLECTURE	
11:20	**Prof Deborah Crittenden**	Chair Prof Ziqi Sun
	University of Canterbury (New Zealand)	
	Predicting Protic Redox Potentials with Error Bars to Facilitate Discovery of Novel Electrolytes for Aqueous Organic Redox Flow Batteries	
11:45	**Dr Junnan Hao**	
	Adelaide University (Australia)	
	New electrolytes and electrodes for aqueous Zn batteries	

	CONTRIBUTED LECTURE	Chair
12:10	**Donghyuck Park**	Prof Ziqi Sun
	University of Melbourne (Australia)	
	Modified carbon black and NMC for improved lithium-ion battery performance	
12:25	**María Ley Flores**	
	University of Chicago (USA)	
	Hierarchical Modelling of Redox-Active Polymers for All Organic Batteries	
12:40	LUNCH + POSTER	
	FACET French-Australian Session	
	INVITED LECTURE	Chair
1:30	**Prof Philippe Poizot**	Prof Pingan Song
	University of Nantes (France)	
	Redox Properties of Viologens Featuring Double Zwitterionic Skeletons for p-Type Electrode Applications	
1:55	**Prof Cyrille Boyer**	
	University of New South Wales (Australia)	
	3D Printed Solid Polymer Electrolytes with Nanoscopic Domains for Energy Storage	
2:20	**Dr Lionel Dubois**	
	CEA-Grenoble (France)	
	Monitoring of organic redox flow batteries by EPR and operando NMR	
	CONTRIBUTED LECTURE	
2:45	**Florian Léveillé**	
	Université de Picardie Jules Verne (France)	
	Solvent-free extrusion of polymer electrolytes for high voltage all solid-state batteries	
3:00	**Yutong Zhu**	
	University of Queensland (Australia)	
	Utilization of perfluorocarboxylic acids in rechargeable batteries	
3:15	AFTERNOON TEA	

	INVITED LECTURE	Chair
3:40	**Prof Ziqi Sun (Australia)**	Dr Cheng Zhang/Dr Shaojian Zhang
	Queensland University of Technology (Australia)	
	Organic molecular promoters in rechargeable batteries	
4:05	**Assoc Prof Steven Renault**	
	University of Nantes (France)	
	Spectator cation effect on bipolar Q-TTF-Q	
4:30	**Prof Luke Henderson**	
	Deakin University (Australia)	
	Carbon Fibre Composites as Structural Energy Storage Materials	
	CONTRIBUTED LECTURE	
4:55	**Manon Mignon**	
	Université de Picardie Jules Verne (France)	
	Molecular-based conductive active material for metal-ion batteries	
5:10	**Lucy McElhone**	
	University of Melbourne (Australia)	
	Optimising the electrochemical performance of manganese (II, III) oxide for lithium-ion battery anodes	
5:25	**Yannis Zekhenine**	
	Université Grenoble-Alpes (France)	
	Synthesis of high redox potential quinolates for energy storage	
5:40	SECOND DAY FINISH	

The 8th Organic Battery Days (OBD2025) International Conference Full Program
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Day 3: Thursday 24th April 2025

	INVITED LECTURE	Chair Dr Xiaodan Huang
9:00	**Assoc Prof Yongjun Li**	
	Shanghai Institute of Organic Chemistry, CAS (China)	
	Backbone Effect on the Energy Storage Performance of Radical Polymers for Organic Batteries	
9:40	**Assoc Prof Manickam Minakshi**	
	Murdoch University (Australia)	
	Organic Electrode Materials for Aqueous Energy Storage System	
10:05	**Asst Prof Wonho Lee**	
	Kumoh National Institute of Technology (South Korea)	
	Synthesis of naphthalenediimide (NDI) based organic cathodes for enhancing capacity	
10:55	MORNING TEA	
	INVITED LECTURE	Chair Dr Junnan Hao
10:30	**Dr Cheng Zhang**	
	University of Queensland (Australia)	
	Block Copolymer Electrolytes: from Molecular Design to Advanced Batteries	
11:20	**Dr Olivera Lužanin**	
	National Institute of Chemistry (Slovenia)	
	Understanding the Performance Discrepancies of Organic Electrodes in Lithium and Magnesium Batteries	
11:45	**Dr Hikaru Sano**	
	National Institute of Advanced Industrial Science and Technology (Japan)	
	Lithium Metal Anode for Use in Organic Cathode Batteries	
12:10	CONFERENCE CONLUDE AND AWARD PRESENTATION	
	Assoc Prof James Blinco	
	Conference co-Chair	
	Queensland University of Technology	
12:30	LUNCH	
13:30	DELEGATES DEPARTURE	

	POSTERS	
P1	**Dr Danfeng Cao**	
	Linköping University (Sweden)	
	All-plant-based stretchable ion-sieving separator for novel wearable electrochemical energy devices	
P2	**Dr Yanlin Shi**	
	Finders University (Australia)	
	Exploring zwitterionic TEMPO for aqueous Zinc-radical redox flow battery	
P3	**Kohei Ishigami**	
	Waseda University (Japan)	
	Viscosity Response to Redox Reaction in Water-Soluble TEMPO-Substituted Polyacrylamide for Aqueous Redox Flow Batteries	
P4	**Rajesh Jethwa**	
	Institute of Science and Technology Austria (Austria)	
	Electroactive Ligating Electrodes	
P5	**Robert Markowski**	
	Université Catholique de Louvain (Belgium)	
	Design Principles of Quinone Redox Systems for Advanced Sulfide Solid-State Organic Lithium Metal Batteries	
P6	**Robert Markowski**	
	Université Catholique de Louvain (Belgium)	
	Computational and Machine Learning-Assisted Discovery and Experimental Validation of Conjugated Sulfonamide Cathodes for Lithium-Ion Batteries	
P7	**Yuta Maeyoshi**	
	National Institute of Advanced Industrial Science and Technology (Japan)	
	π-Conjugated Polymers for Lithium Metal Anodes	
P8	**Chanaka Mudugamuwa**	
	Flinders University (Australian)	
	Cellulose-based cathode material for aqueous zinc-ion battery	
P9	**Shangxu (Simon) Jiang**	
	Flinders University (Australia)	
	Cyclodextrin-based Polymer Gels as Host Materials for High-Performance Zinc-I_2 Batteries	

Electrolyte and Interfacial Engineering for Aqueous Zn Metal Batteries

Ho Seok Park[1,2,3]*

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Keywords: Electrolytes, Interface, Aqueous batteries, Zn metal, Additives

Multivalent-metal anodes, such as aluminum, zinc, magnesium, and calcium, are very attractive owing to their high theoretical capacity, natural abundance, and high safety. However, electrochemical performance and stability of multivalent-metal anodes are also deteriorated due to Zn dendrite formation, corrosion, and hydrogen evolution reaction in aqueous electrolytes.[1] In this talk, I will introduce our recent progress on the electrolyte additives and the associated interfacial engineering for reversible Zn and Al deposition of Zn metal and Zn-Al alloy anodes.[2-5] Computational and experimental results correlate the solvated structure and interfacial chemistry of hybrid electrolytes with facile and stable Zn- and Al-ion plating/stripping behaviour occurring on the surface of Zn metal and Zn-Al alloy anodes.[2,3] Inspired by biological or natural systems, our new multifunctional additives that can modulate solvation structures, interfacial chemistry, and EDL structures will be addressed.[4,5]

References:

[1] G. Wang, Q.-K. Zhang, X.-Q. Zhang, J. Lu, C. Pei, D. H. Min, J.-Q. Huang, H. S. Park, *Adv. Energy Mater.*, 2304557 (2024).
[2] Q. Dou, N. Yao, W. K. Pang, Y. Park, P. Xiong, X. Han, H. H. Rana, X. Chen, Z.-H. Fu, L. Thomsen, B. Cowie, Y. Kang, Q. Liu, D. H. Min, Y. M. Jung, Z. Guo, Q. Zhang, H. S. Park, *Energy Environ. Sci.*, **15**, 4572–4583 (2022).
[3] P. Xiong, Y. Kang, N. Yao, X. Chen, H. Mao, W.-S. Jang, D. M. Halat, Z.-H. Fu, M. H. Jung, H. Y. Jeong, Y. M. Kim, J. A. Reimer, Q. Zhang, H. S. Park, *ACS Energy Lett.*, **8**, 1613–1625 (2023).
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[5] H. Fu, S. Huang, T. Wang, J. Lu, P. Xiong, K. Yao, J. S. Byun, W. Li, Y. Kim, H. S. Park, *Adv. Mater.*, 2411686 (2024).

A brief CV of the speaker

Ho Seok Park Professor

Sungkyunkwan University

Ho Seok Park is a direct of Center for 2D Redox Energy Storage (2DRES), a full professor of Chemical Engineering at the Sungkyunkwan University (SKKU), an adjunct professor at the Samsung Advanced Institute for Health Science & Technology (SAIHST), and SKKU Fellow. His current research interests focus on electrochemical energy storage and conversion devices based on 2D and carbon nanomaterials and polymer electrolytes. He has published more than 330 papers in the top journals, including Nature Materials, Joule, Chem. Soc. Rev., Energy & Environ. Sci., Nature Commun., Adv. Mater., Angew. Chem., JACS, Nano Lett., ACS Nano, etc, and been taking associate and guest editor and editorial board member in the SCI(E) journals of InfoMat, Adv. Funct. Mater., NEXT Energy, Energy Materials, Batteries & Supercaps, J. Phys. Energy, Materials Today Energy, and so on. He has been recognized by several awards including the Korean Academy of Science and Technology (*KAST*) Member, Commendation from *Ministry of Science and ICT* Minister, EnSM Young Scientist Award, S-OIL Young Scientist Award, National R&D Excellence 100 in 2019, the Scientist of the Month, the LG Yeonam Fellowship, and so on.

Porous Framework Materials such as MOFs, COFs, and HOFs With Redox-Active Units as Cathodes in Lithium- and Sodium-Ion Batteries

Hirofumi Yoshikawa[1] and Katsuhiro Wakamatsu[1]
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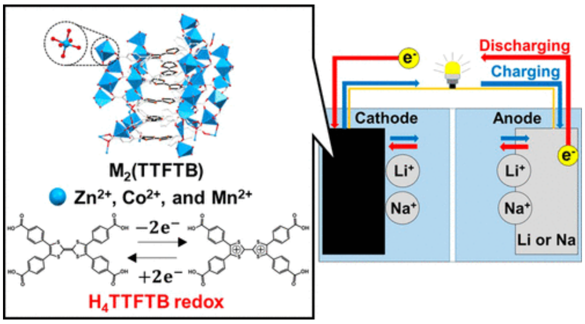

Tetrathiafulvalene (TTF) derivatives are well-known molecular-based conductors. They are used to prepare porous crystalline structures with efficient charge transport properties and suitable chemical design, such as metal−organic frameworks (MOFs), covalent organic frameworks (COFs), and hydrogen-bonded organic frameworks (HOFs). MOFs based on TTF derivatives have attracted attention as electrode-active materials for rechargeable metal-ion batteries owing to multielectron redox reactions, resulting in improved battery capacity. This study focuses on TTF−tetrabenzoate (H4TTFTB), which exhibits good redox and mechanical properties as the ligand of MOFs. We evaluated the battery performance using MOFs based on H4TTFTB with three types of core metals ([M2(TTFTB)], where M = Zn, Co, and Mn) as cathode active materials for rechargeable lithium-ion and sodium-ion batteries (LIBs and SIBs). The cycle stability and battery capacity at high current densities were improved by MOF formation in both LIBs and SIBs, indicating that MOF formation has the potential to achieve improved charging/discharging rates. In addition, the battery capacities and cycle stability of SIBs were larger than those of LIBs for all materials. These results demonstrate the interesting battery performance of MOFs based on H4TTFTB as cathode active materials for LIBs and SIBs. This implies that the application of redox-active and rigid H4TTFTB as the ligand of MOFs is an effective method for realizing high-performance energy storage devices. These findings can contribute to an improved design of cathode active materials for high-performance rechargeable metal-ion batteries for sustainable energy storage. In the presentation, battery performances of hydrogen-bonded Organic frameworks with redox active imide units as sodium and lithium-ion batteries are also discussed.

References:
1. H. Yoshikawa et al., *ChemElectroChem*, **2024**, e202300607
2. H. Yoshikawa et al., *ACS Appl. Energy Mater.*, **2023**, 6, 18, 9124–9135 (**Supplementary Cover**)

Biography

Hirofumi Yoshikawa is a professor at Kwansei Gakuin University. He received his Ph.D. degree in inorganic chemistry from the University of Tokyo, in 2003. His research interests focus on electrochemistry and rechargeable batteries using organic and inorganic compounds, such as polyoxometalates and metal organic frameworks.

Creating a Super Anode for Lithium-ion Batteries

Kiet Pham, Mehrdad Parsa, Gopalakrishnan Kothandam and Amanda V. Ellis
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To satisfy global energy demands higher capacity lithium-ion batteries (LIBs) are required. Conventional commercial LiBs have anodes made up of graphite which undergo intercalation/deintercalation of lithium-ions (Li-ions) into/out of the graphite that allows it to last for thousands of cycles. However, while 6 carbon atoms in the graphite aromatic rings can hold 1 Li atom (LiC6, 372 mA h g^{-1}) [1], silicon (Si) can accommodate up to 3.75 Li atoms ($Li_{15}Si_4$, 3579 mA h g^{-1}) at room temperature, making Si one of the most promising candidates for increasing the capacity of LIBs [2]. This work studies the question of: If graphite and Si were combined, will they lithiate/delithiate independent of each other, or will there be an enhancement/ hindrance in their performance? In this work, 0 wt% to 15 wt% Si nanoparticles were blended with natural graphite to investigate the overpotential and Li^+-ion diffusion coefficients of these Si/graphite mixtures using differential capacity (dQ/dV) analysis, and the galvanostatic intermittent titration technique (GITT). Generally, the capacity increases while the capacity retention decreases when increasing the Si content in these mixtures. In addition, the Li^+-ion diffusion coefficients decrease and the overpotential increases when the Si content increases in Si/graphite mixtures, which causes a loss in capacity, a decrease in energy density, and an increased possibility of Li metal electroplating. The results show that there is an interplay between graphite and Si during the Li^+-ion diffusion process, which provides insights into synergistic and antagonistic effects of Si nanoparticles (0-15 wt%) blended with natural graphite [3].

References:
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2. Siczek, K.J.; *Next-Generation Batteries with Sulfur Cathodes* **2019**, 117-131.

Biography. Prof. Amanda Ellis is the Head of the School of Chemical and Biomedical at The University of Melbourne. Her research work focuses on carbon and DNA nanomaterials, polymer science and energy harvesting/storage devices. She has secured over $38 M in funding from the ARC and non-ARC sources as well as publishing over 195 peer-reviewed publications (>9400 citations) and holds 6 patents. She is currently the President of the Royal Australian Chemical Institute (RACI) (President Nov 2024- Nov 2026).

Block Copolymer Electrolytes: from Molecular Design to Advanced Batteries

Cheng Zhang[1,2*]
[1]Australian Institute for Bioengineering and Nanotechnology (AIBN), The University of Queensland, QLD, Australia
[2]Centre for Advanced Imaging, The University of Queensland, QLD, Australia
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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 block 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.

Reference

(1) Zhang, C.; Yan, K.; Fu, C.; Peng, H.; Hawker, C. J.; Whittaker, A. K. Biological Utility of Fluorinated Compounds: from Materials Design to Molecular Imaging, Therapeutics and Environmental Remediation. *Chem. Rev.* **2022**, *122* (1), 167-208. DOI: 10.1021/acs.chemrev.1c00632.
(2) Wang, X.; Zhang, C.; Sawczyk, M.; Sun, J.; Yuan, Q.; Chen, F.; Mendes, T. C.; Howlett, P. C.; Fu, C.; Wang, Y.; et al. Ultra-stable all-solid-state sodium metal batteries enabled by perfluoropolyether-based electrolytes. *Nat. Mater.* **2022**, *21* (9), 1057-1065. DOI: 10.1038/s41563-022-01296-0.
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(4) Zhou, C.; Cheng, Z. Engineering electrode microstructures for advanced lithium-ion batteries. *Microstructures* **2024**, *4* (3), 2024033. DOI: 10.20517/microstructures.2023.89.
(5) Wang, Y.; Wu, Z.; Azad, F. M.; Zhu, Y.; Wang, L.; Hawker, C. J.; Whittaker, A. K.; Forsyth, M.; Zhang, C. Fluorination in advanced battery design. *Nat. Rev. Mater.* **2023**, *9* (2), 119-133. DOI: 10.1038/s41578-023-00623-4.

Dr Cheng Zhang is a Group Leader and an Australian Research Council DECRA Fellow (former National Health and Medical Research Council Fellow) at the Australian Institute for Bioengineering and Nanotechnology (AIBN), The University of Queensland (UQ) where he leads a research group in polymer chemistry and PFAS remediation. His research focuses on the development of advanced polymerization, purification and characterization techniques to prepare well-defined functional polymers with precisely-tailored properties for important applications from PFAS remediation, energy materials e.g. solid electrolytes to functional biomaterials e.g. imaging and therapeutic agents. He has published over 85 journal articles, including *Nature Materials*, *Nature Reviews Materials*, *Chemical Reviews*, *Journal of the American Chemical Society*, *ACS Nano*, *Macromolecules* and etc. As CIA, he has successfully secured a number of competitive research grants from Australian Government, UQ and US DoD (>$7 million AUD), regularly receives invitations to speak at national/international conferences (>30 to date), and has received numerous awards, including most recently Young Tall Poppy Award, Queensland Fresh Scientist, ACS Materials AU Rising Star, and UQ Industry Engagement Award.

3D Printed Solid Polymer Electrolytes with Nanoscopic Domains for Energy Storage

Kenny Lee,[1] Qian Huang,[1] Nathaniel Corrigan,[1] Dipan Kundu,[2,3] Cyrille Boyer[1]
[1]*School of Chemical Engineering, UNSW, Australia, Cluster for Advanced Macromolecular Design (CAMD), Sydney, NSW, 2052 Australia*
[2]*School of Chemical Engineering, UNSW Australia, Sydney, NSW, 2052 Australia*
[3]*School of Mechanical and Manufacturing Engineering, UNSW Australia, Sydney, NSW, 2052 Australia*

Solid polymer electrolytes (SPEs) offer significant advantages over liquid electrolytes, driving research towards materials with enhanced mechanical strength and high ionic conductivity. We utilized digital light processing 3D printing, leveraging polymerization-induced microphase separation (PIMS), a technique that precisely controls nanodomain formation during polymerization to create tailored nanostructures, to fabricate nanostructured SPEs with independently tuneable properties. In this process, a macrochain transfer agent (macrCTAs) is chain extended in the presence of monomers and crosslinkers to yield a nanostructured material containing rigid and soft bicontinous domains. A rigid crosslinked network achieved shear moduli above 400 MPa, while soft domains, incorporating an ionic liquid, yielded ionic conductivities up to 1.2 mS cm^{-1} at 30 °C. The influence of parameters such as macroCTA molecular weight, architecture, and type on the resulting SPE properties (modulus and conductivity) will be presented. This 3D-printed SPE demonstrates promising potential for all-solid-state energy storage devices, including supercapacitors.

References:

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Biography

Scientia Professor **Cyrille Boyer** is an Australian Laureate Fellow at the University of New South Wales, who is specialized in synthesizing functional macromolecules for applications in nanomedicine, advanced materials, and energy storage. He has pioneered photoinduced electron/energy transfer – reversible addition fragmentation chain transfer (PET-RAFT) polymerization (an efficient living radical polymerization which can be activated by light), synthetic bioactive macromolecules (such as antimicrobial polymers), and 3D printing methods for precise control over nano- and macro-structures. He has coauthored over 420 articles, which have generated over 41,000 citations, resulting in H-index of 110 (Google Scholar). He has received several awards, including the 2016 ACS Macro Letters/Biomacromolecules/Macromolecules Young Investigator Award, 2018 IUPAC-Polymer International Young Researcher award, 2015 Lefevre Award from the Australian Academy of Science, and the 2015 Malcolm McIntosh Prize for Physical Science (one of the Prime Minister Prizes for Science). Consistently recognized as a Highly Cited Researcher since 2018, he is also acknowledged as a leader in polymers and plastics in Australia by the Australian Newspaper in 2024.

Predicting Protic Redox Potentials with Error Bars to Facilitate Discovery of Novel Electrolytes for Aqueous Organic Redox Flow Batteries

Lachlan O. Smith & Deborah L. Crittenden[1]
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Aqueous organic redox-flow batteries are attracting increasing research attention, thanks to their relatively low cost, low volatility, high stability of redox products, availability of compatible ion-exchange membranes and favourable safety profiles. Another potential advantage of organic redox-active electrolytes is that their redox potentials may, in principle, be optimized by rational molecular design. Although it is straightforward to model substituent effects on known redox-active scaffolds (e.g. quinones[1,2], tricyclic heteroaromatics[2], indigos[2]), it is much harder to confidently predict redox potentials for novel redox-active species. In large part, this can be traced back to the fact that multiple mechanisms are usually possible, involving different numbers of electrons and/or protons and possibly forming different tautomeric and/or isomeric products, each with very different characteristic redox potentials. This is further compounded by the inherent uncertainty in quantum chemical predictions of redox potentials arising from methodological choices, e.g. choice of density functional or wavefunction method, basis set and solvation model.

In this talk, we outline an efficient computational procedure that enables us to accurately estimate redox potentials with associated computational uncertainties that reliably bound experimental values for a series of benchmarking compounds with known protic redox mechanisms. We also demonstrate how this approach may be used to determine unknown mechanisms and/or elucidate protic redox potentials for all possible redox processes that a novel species may undergo.

References:

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Ding, Y., Zhang, C., Zhang, L., Zhou, Y., & Yu, G. Molecular engineering of organic electroactive materials for redox flow batteries. *Chemical Society Reviews*, **2018**, *47*(1), 69-103.

Biography

Professor Deborah Crittenden is a physical and theoretical chemist from the University of Canterbury, Christchurch, New Zealand. She has a broad range of research interests and experience, ranging from development of electronic and nuclear vibrational structure methods through to the design and experimental implementation of novel diagnostic and energy storage technologies. Her redox flow battery research focusses on the development of organic redox-active ionic liquids as high energy density electrolytes, and she has pioneered a novel approach for characterising redox potentials of these species in carrier ionic liquids, alongside developing computational methods for predicting redox potentials.

Wiring Proton Gradients for Energy Conversion Using Light-Switchable Molecular Switches

Dong Jun Kim[1]
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Harnessing light energy for sustainable energy conversion is a key challenge in developing next-generation energy technologies. In this work, we introduce a novel approach using light-activated molecular switches based on merocyanine photoacids to create and control proton gradients in aqueous environments. By carefully manipulating the solvation environment in water-methanol mixtures, these molecular switches can achieve significant changes in acidity, leading to proton concentration gradients of up to 4 pH units under targeted 500 nm light. This controlled light-induced proton transfer process is capable of generating stable open-circuit voltages up to 240 mV.

This research opens new avenues for the design of photo-responsive materials with potential applications in solar energy harvesting. The precise control of proton gradients through molecular switches not only mimics biological energy transduction but also offers a scalable strategy for developing efficient and sustainable energy conversion technologies. Our findings underscore the potential of integrating molecular switches into functional devices, paving the way for advancements in the field of artificial molecular systems and beyond.

References:
X. Dai, C. Berton, D. J. Kim*, C. Pezzato*, **2024**, 15, 19745-1975

Biography Dr. Kim is a Senior Lecturer and DECRA Fellow at the School of Chemistry, UNSW Sydney, where he leads a research group dedicated to supramolecular materials for energy storage and artificial molecular machines. He earned his B.S. from Yonsei University in 2010 and completed his Ph.D. at KAIST in 2015. Following his doctoral studies, he joined Northwestern University as a postdoctoral researcher under the mentorship of Sir Fraser Stoddart. Since establishing his independent research group at UNSW Sydney in October 2018, he has focused on the design and synthesis of supramolecular compounds for energy storage applications.

Fluorine-Free Poly(vinylphenothiazine)-based Batteries with Solid Polymer Electrolytes

Isabell Lee Johansson, Timofey Kolesnikov, Philipp Penert, Birgit Esser, Fabian Jeschull,
Guiomar Hernández[1]
[1]Department of Chemistry, Ångström Laboratory, Uppsala University, SE-751 21 Uppsala, Sweden
Email: guiomar.hernandez@kemi.uu.se

Although organic batteries are considered more sustainable than lithium-ion batteries, the rest of the battery components and processes used tend to be the same in both chemistries. Examples of the components which could also benefit from more sustainable alternatives are poly(vinylidene fluoride) binder and lithium bis(trifluoromethanesulfonyl)imide. These two components fall in the category of per- and polyfluoroalkyl substances (PFAS) which are known as “forever chemicals” due to their long persistence and tendency to pollute the environment. Finding alternatives to these chemicals is key towards more sustainable batteries, not least organic batteries.

Alternative fluorine-free components for poly(vinylphenothiazine)-based organic batteries will be presented. The binders studied are poly(ethylene oxide) and poly(caprolactone) which have been used as solid polymer electrolytes as well to enhance the electrode-electrolyte compatibility. Furthermore, the effect of the salt anion on the redox reaction has been studied with hexafluorophosphate, bis(trifluoromethanesulfonyl)imide (TFSI) and bis(oxalato)borate (BOB) in both liquid and solid electrolyte. Results show promising electrochemical performance for fully fluorine-free organic batteries.

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Savvidou E.K., Rensmo A., Benskin J.P., Schellenberger S., Hu X., Weil M., Cousins I.T., *Environ. Sci. Technol.* **2024**, 58 (50), 21908-21917.

Biography
Guiomar Hernández is an Assistant Professor at the Ångström Advanced Battery Centre at Uppsala University (Sweden), since 2022. She obtained her PhD at the University of the Basque Country (Spain) in 2017 on redox-active polymers for energy storage applications. Currently, she is leading a team working on polymeric materials and electrolytes (solid and liquid) for safe and sustainable next-generation batteries.

Lithium Metal Anode for Use in Organic Cathode Batteries

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The utilization of renewable energy with secondary lithium batteries is crucial for addressing environmental issues. The use of organic materials in secondary batteries is beneficial due to their abundance and minimal environmental impact. Some organic cathode materials, such as quinones, have high specific capacities. These materials often start from an initial discharge process, which is well-suited for use with reduced materials as anode. Among these anode materials, metallic lithium stands out due to its high specific capacity, resulting in batteries with high energy densities. However, metallic lithium poses challenges such as dendrite formation and low Coulombic efficiency. Coulombic efficiency decreases due to side reactions and the formation of dead lithium during dendrite dissolution. Dendrites can lead to internal short circuits and increased risks during thermal runaway. For suppression of dendrite formation, uniform current distribution should be ensured addressing uneven ion flow caused by the uneven solid electrolyte interphase (SEI) and uneven separator micropores. To elucidate these concepts from a fundamental scientific perspective, we conducted analyses using ionic liquids with high reduction stability as electrolytes.[1]

Recently, we also explored the use of $LiBH_4$-based organic liquid electrolytes. Although $LiBH_4$ is also studied as a solid-state electrolyte, its use in a liquid electrolyte offers unique benefits, such as high reduction stability and altered lithium deposition morphology, crucial for preventing dendrites.[2] However, its low oxidation stability makes it unsuitable when used in cathodes. The findings suggest $LiBH_4$-based electrolytes offer insights into developing lithium metal anodes without dendrites and with higher Coulombic efficiency, contributing to future innovations in battery technology.

This work was partially supported by JST GteX Program (Grant Number: JPMJGX23S3).

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Biography

Dr. Hikaru Sano is a distinguished researcher at the National Institute of Advanced Industrial Science and Technology (AIST), a national laboratory in Japan. He earned his B.S., M.S., and Ph.D. in Materials Engineering from Kyoto University, Japan. Dr. Sano has been with AIST since 2009, where he currently serves as a Chief Senior Researcher. His research focuses on charge-discharge mechanism elucidation and cycle performance evaluation of organic cathodes, lithium metal anode utilization, and the moisture resistance evaluation of sulfide solid electrolytes. Dr. Sano aims to contribute to advancements in battery technology, enhancing the performance and safety of electric vehicles and other applications. He is highly regarded in his field and has published several papers in respected journals.

Stable and Fast Redox Fe-Complex Negolytes for Near-Neutral Aqueous Redox Flow Batteries

Donghwi Ko,[1] Seongyeon Kwon,[2] Dong-wook Kim,[2] Yunseop Choi,[3] Xinyu Lyu,[4] Tao Li,[4] Jongcheol Seo,[3] Mu-Hyun Baik,[2] and Hye Ryung Byon[1,]*

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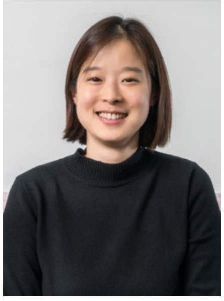
Cost-effective redox-active materials are essential for advancing redox flow batteries (RFBs). Iron, an abundant redox material, is promising, yet achieving stable and fast redox reactions in aqueous RFBs remains challenging. Our study presents a Fe-based negolyte stabilized by a hexadentate ligand, where Fe–ligand bonds are enhanced through intermolecular interactions. Sulfonate-substituted Fe complex exhibits a formal potential of –0.44 V vs. Ag/AgCl and an exceptional rate constant of 0.78 cm s–1. Near-neutral RFBs with 0.5 M Fe complex show excellent stability over 300 cycles without capacity fading. This result is attributed to hydrogen bonding, which reinforces Fe–ligand coordination and promotes trimeric cluster formation, in contrast to that of the hydroxyl-substituted Fe complex. Operando Raman spectroscopy and DFT reveal that π-backdonation from Fe(II) to the imino-phenolate moiety further stabilizes the complex after reduction. These findings underscore the importance of ligand design and intermolecular interactions in developing stable Fe complexes.

Biography



Hye Ryung Byon received her Ph. D. degree in chemistry at POSTECH in 2008. Then, she worked at MIT as a post-doctoral associate. In 2011, she launched her independent research group, Byon Initiative Research Unit, at RIKEN in Japan. After 5 years, she moved to KAIST, South Korea. She is currently an associate professor at KAIST and also KAIST Institute. She received several awards, including TJ Park Science Fellowship (POSCO), The Distinguished Lectureship Award (Chemical Society of Japan) in 2017, The Young Scientist Award (The Korean Academy of Science and Technology) in 2018, The I-sense Young Electrochemist Award (Korea Chemical Society) in 2020, and The Science and Technology Prize (Korea Toray Science Foundation) in 2021, for outstanding work in electrochemistry, energy storage, and energy conversion sciences.

In situ Electrochemical Crosslinking Enables High-Rate Performance of Organic Electrodes through Self-Nanostructuring

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Organic electrode materials (OEMs) are attracting significant attention as promising alternatives to conventional inorganic electrode materials for secondary batteries. This interest driven by several advantages, including their abundance, sustainability, biocompatibility, cost-effectiveness, and ease of chemical modification. Notably, the flexible nature of their intermolecular packing structures with large free volumes are expected to facilitate rapid diffusion of charge-carrying ions, which is essential for achieving high-rate performance of battery electrodes.

Despite these advantages, their practical use faces critical challenges. Their inherently poor electrical conductivity hinders both rate capability and capacity utilization, while their high solubility in organic electrolytes leads to rapid capacity fading during the initial few cycles. So far, to address these issues, most studies have focused on preparation of polymers, open framework materials, and/or nanocarbon composites. However, such strategies often require additional complex synthesis steps and/or costly nanocarbons. Moreover, making OEMs insoluble can lead to the formation of large agglomerates during the electrode fabrication, further deteriorating the rate performance and capacity utilization.

In this talk, we present several post-crosslinking strategies applied after fabricating electrodes with soluble small-molecule OEMs, aimed at improving their both cycle stability and rate performance. In particular, in situ electrochemical crosslinking during the initial cell-forming process triggers self-restructuring inside the electrodes to form peculiar nanostructures that facilitate the electrochemical reactions. Notably, our new electrochemical coupling process neither produces any byproduct nor extends π-conjugation length, unlike conventional dimeric coupling reactions. We believe that these strategies can pave the way for the development of fast-rechargeable and highly stable batteries.

Biography (10pt, one paragraph with a headshot)
Ji Eon Kwon received his BS and Ph. D. degrees in Materials Science and Engineering from Seoul National University in 2006 and 2014, respectively, under the supervision of Prof. Soo Young Park. In 2016, he was appointed Korea Presidential Post-doc. Fellow. Since 2020, he has served as a Senior Researcher at Korea Institute of Science and Technology (KIST).

New electrolytes and electrodes for aqueous Zn batteries

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Aqueous Zn batteries (AZBs) have inspired an overwhelming number of literature studies due to their safety, cost effectiveness, and environmental benignity. Directly employing metallic Zn foil as an anode significantly simplifies battery manufacturing and simultaneously broadens the operating voltage window of aqueous batteries, benefiting from its high overpotential against electrolyte decomposition. Nevertheless, serious issues, such as dendrite growth and side reactions, occurring at the Zn/electrolyte interphase, make the Coulombic efficiency and lifespan of Zn metal electrodes far from satisfactory, which has also been motivating new research interest in interfacial engineering to solve these problems. Owing to the rapid evolution of this new area, it is highly desirable to provide current and timely updates of interfacial strategies and their effectiveness evaluation. From the two sides – the electrode and the electrolyte at the interphase – this report thoroughly summarizes our fundamental understanding of interfacial strategies, including designing mechanisms, creating new methods, and technical challenges. Importantly, this report also analyses the effectiveness evaluation techniques for interfacial strategies, including electrochemical methods, characterization measurements, and computational simulations, providing guidelines for the accurate evaluation and analysis of AZBs in the future.

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Biography

Junnan Hao received his PhD degree in 2020 from the University of Wollongong, Australia. Now he works as a DECRA fellow at the University of Adelaide, Australia. As an early career researcher, he has already demonstrated an exceptional track record, reflected by the publication of 90 refereed papers in peer-reviewed journals, including 3 ESI Hot papers (top 0.1%) and 26 ESI Highly Cited papers (top 1%). These include 39 papers as the first/co-first author and corresponding author, including: *Proc. Natl. Acad. Sci. USA., Chem. Soc. Rev., Angew. Chem, Adv. Mater., Energy Environ. Sci., etc.* His research interests are focused on energy storage and conversion, including aqueous Zn-ion batteries, high-voltage Li-ion batteries, dual ion batteries, and flexible energy storage devices. He was also granted by *Clarivate Highly cited researcher*, *The Australian Battery Society* as *ABS Energy Renaissance Innovator, ARC DECRA*, and *AINSE Early Career Researcher Award* (Australian Synchrotron) etc.

H_2O Unlocks New Redox Pathways in Organic Cathode Batteries

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Abstract

Organic cathode materials hold great promise for sustainable energy storage, but their redox behaviour is highly dependent on the electrolyte environment. This presentation highlights how water fundamentally alters energy storage mechanisms in two distinct organic systems. In azopyridine-based zinc-ion batteries, aqueous electrolytes promote proton-coupled redox reactions and induced the disproportionation of azo radicals, resulting in a significant voltage uplift (up to 1.4 V) and high capacities (~200 mAh g^{-1}). Similarly, in aluminium-ion systems, water enables a reversible redox cycle for nitroxide radicals, which otherwise undergo irreversible disproportionation in organic media. By facilitating ligand exchange and stabilizing reactive intermediates, aqueous $Al(OTf)_3$ allows for the first demonstration of a radical polymer aluminium battery with exceptional cycling stability and fire-retardant properties. These findings collectively demonstrate that water, rather than degrading performance, can mitigate limitations of organic cathodes and unlock new electrochemical pathways for high-performance, safe, and cost-effective batteries.

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Biography

Kai Zhang received his Ph.D. in Science from the University of Queensland, Australia, in 2018, under the supervision of Dr. Zhongfan Jia from the Australian Institute for Bioengineering and Nanotechnology and Professor Michael Monteiro. From 2018 to 2020, he conducted postdoctoral research at Johns Hopkins University, USA. In 2020, he joined the College of Chemistry and Chemical Engineering at Zhejiang Sci-Tech University as a Distinguished Associate Professor. His primary research focuses on energy and polymer chemistry, with research interests including the mechanistic study and structural design of aluminum-ion batteries, polymer-based flexible batteries, and aqueous organic redox flow batteries. He has published over ten research papers as the corresponding/first author in prestigious journals such as J. Am. Chem. Soc., ACS Energy Lett., Energy Storage Mater., J. Mater. Chem. A, and Chem. Eng. J., which have gained significant attention from the academic community both domestically and internationally.

High-density Lithium Sulfur Batteries with Polymeric Sulfur Electrodes

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Lithium-sulfur batteries have attracted significant attention due to the high capacity of sulfur as the cathode-active material. When a solid electrolyte is employed, concerns regarding the elution of polysulfide ions into the electrolyte dissipate. However, the charge/discharge rate characteristics of the solid-state lithium-sulfur batteries are lower than those with an organic electrolyte. In this study, we synthesized a sulfur-containing elastomer polymer, which exhibits enhanced flexibility compared to elemental sulfur. Our findings demonstrate that this polymer significantly improves the rate characteristics by reducing interfacial resistance.

The sulfur-containing polymer was synthesized by inverse vulcanization, a process in which cyclic sulfur opens up to form a radical, and the monomer polymerizes to yield a polymer with a polysulfide structure. A linear polymer was obtained by using a monomer with one C=C double bond and elemental sulfur, to which was added a cross-linking agent to produce a cross-linked polymer. The mixture of a monomer Span 80, elemental sulfur, and zinc diethyldithiocarbamate as a catalyst was stirred under heating conditions. Subsequently, a cross-linking agent, bisphenol A diglycidyl ether, was incorporated, and the mixture was subjected to further heating to yield the desired product. The cross-linking densities were tuned by incorporating different equivalents of the cross-linking agent.

Elemental sulfur demonstrated a discharge capacity of ca. 1500 mAh/g at 0.1 mA/cm^2, but it decreased at higher current densities. The discharge capacity of the densely cross-linked polymer remained low; however, the less cross-linked polymers with relatively low Young's modulus and storage modulus exhibited larger capacities than that of pure sulfur at all current densities. The softness of the sulfur cathode seemed to facilitate contact at the solid-solid interface, thereby maintaining a conductive path.

Biography
Kenichi Oyaizu is a professor at Waseda University in Tokyo, Japan. His research focuses on the development of functional polymers with an emphasis on energy-related materials and devices. He has been honored with Prizes for Science and Technology, the Commendation for Science and Technology from the Minister of Education, Culture, Sports, Science and Technology, Japan in 2013, and the Award of the Society of Polymer Science, Japan in 2022.

High Energy Organic Cathodes for Lithium and Zinc

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[3]Ikerbasque, Basque Foundation for Science, Maria Diaz de Haro 3, E-48011Bilbao, Spain
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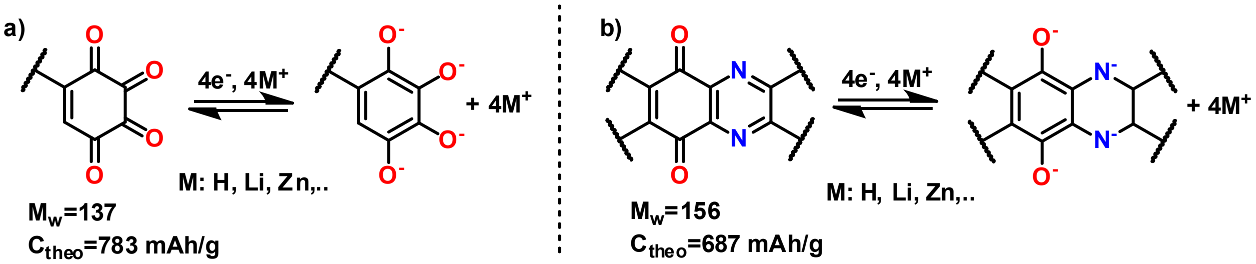
Carbonyls are one of the most common Organic cathode materials. They offer high specific capacities up to theoretical limit 957 mAh/g according to one electron reaction per carbonyl (C=O) group. Most of carbonyls are quinones with only two C=O groups per benzene ring thus limiting theoretical capacity to 496 mAh/g. In practice due to additional inactive atoms and lower utilization typical capacities 200-400 mAh/g can be extracted for quinones. To reach higher capacities we tried two strategies which will be presented during conference: a) Increased number of quinone groups per benzene ring[1] b) Combination of quinone and pyrazine motifs.[2-4]



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Biography Dr. Klemen Pirnat main research interest are carbonyl cathode materials with high capacity and good cycling stability. This includes small organic compounds and polymers. His research include organic synthesis, electrochemical tests in Lithium, Zinc and Magnesium batteries and additional characterization of their redox mechanism.

Monitoring of organic redox flow batteries by EPR and operando NMR

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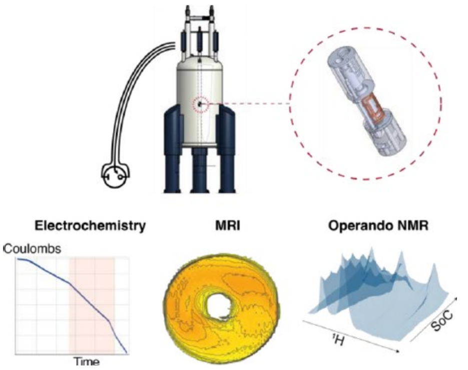

Redox flow batteries are devices developed primarily for stationary storage applications, in which soluble organic redox molecules are considered as prime candidates to replace vanadium traditionally used as electrolyte. There are several issues associated with the use of organic redox molecules for energy storage applications. Chief among these is the question of the redox species involved, their diffusion in solution and the associated degradation mechanisms. This issue is further complicated by the fact that the redox species present in these batteries are at concentrations greater than those typically observed in conventional electrochemical studies (typically in the range of 10^{-3}M), namely >1M.

Magnetic resonance techniques (NMR and EPR) are techniques of choice for analysing organic molecules. They complement each other as NMR is well suited to analyse diamagnetic molecules while EPR is specific to paramagnetic ones. Both provide information on an atomic, molecular and structural scale; they can be used to study the diffusion of species in solution, and in the case of NMR to perform imaging (MRI). Thus, operando NMR on organic redox flow batteries facilitates the tracking of numerous parameters, including nature of the involved species, degradation mechanisms, diffusion of species. Also the velocity map of the circulating electrolytes is an easily accessible parameter. However, it should be noted that NMR does require the use of intense magnetic fields and of radio-frequency waves, which is challenging in terms of compatibility with the conductive materials employed in the electrodes.

In this presentation, the work carried out at the CEA in the field of operando NMR of redox flow batteries will be presented, along with the results obtained with a reference molecule, 2,7-anthraquinone-disulphonic acid. Finally, recent trials involving the development of various devices for studying electrochemical reactions using EPR will be presented.

B. Caja-Munoz, K. Chighine, J. P. Dognon, L. Dubois, P. Berthault, *Anal. Chem.* **2023**, 95, 6020-6028.

Biography

L. Dubois (Dr., Ing.) is researcher at the French Atomic Commission since 2005. He is currently at the head of the laboratory of “Conception of molecular achitecture and electonic process”. His main interest deals with new technologies for energy with a strong focus on the use of organic redox molecule in energy storage. He also developp graphene chemistry for applications ranging from supercapacitor, metal extraction or catalysis.

Carbon Fibre Composites as Structural Energy Storage Materials

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Zan Simon,[1] Leif Asp.[2]
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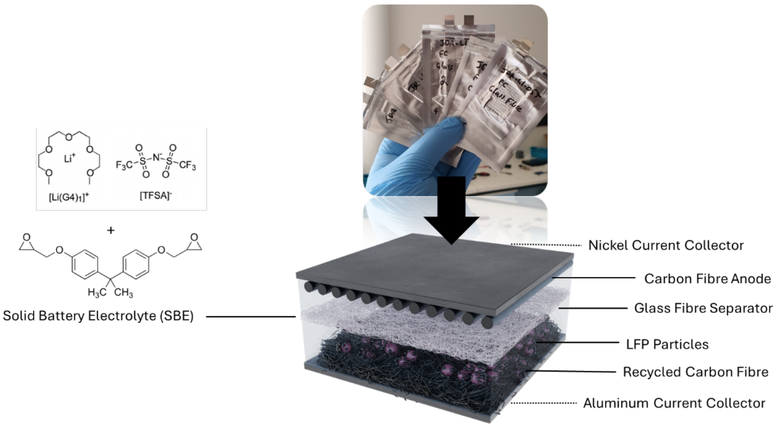
Structural batteries represent an innovative approach to energy storage, integrating the functions of a battery with those of a structural component. Utilizing carbon fiber composites, these advanced materials offer high strength-to-weight ratios, making them ideal for applications in aerospace, automotive, and other industries where reducing weight is crucial.

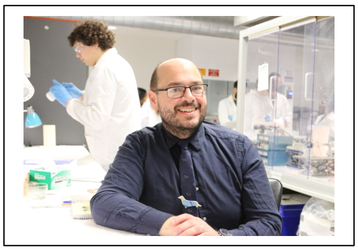
In structural batteries, carbon fibers serve as electrodes, while a polymer electrolyte facilitates lithium-ion movement during charging and discharging. This integration allows the composite to not only support mechanical loads but also store energy, thus optimizing design by merging structural and power functions and potentially reducing the need for separate battery packs.

Research into structural batteries focuses on enhancing energy density, mechanical performance, and durability, while minimizing weight. The ability to produce lighter vehicles or aircraft can lead to improved fuel efficiency and overall performance, making structural batteries an attractive option for next-generation technologies.

This talk will give an update on our work towards developing a capability in this application, primarily focussing on the practical challenges around the use of structural energy. This includes the need to manufacture these materials in open air, on large scales, and optimising adhesion between the fibres and their polymer electrolyte matrix.



Structural Carbon Fibre Composite Battery



Biography Luke C. Henderson obtained his B.Sc., honours, and PhD from Griffith University in 2008. His focus on materials chemistry started in 2015 and now his focus is on the manipulation of material properties via tailoring surface chemistry. He was promoted to Professor in 2020 and leads an array of projects on surface and interface science across academic and industrial sectors. He is currently an ARC Mid-Career Industry Fellow.

Organic Electrode Materials for Aqueous Energy Storage System

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Engineering and Energy, Murdoch University, Perth, WA 6150, Australia
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Aqueous energy storage (batteries/supercapacitors) chemistries featuring low-cost, non-flammable, safe, and sustainable water-based electrolytes provide reliability and cost advantages over competing organic non-aqueous chemistries, as they do not require complex battery management systems [1]. To date, aqueous battery research has focused on the same transition-metal resources that are used in the non-aqueous energy storage counterparts (Ni, Co, Mn-based cathodes) [1]. The current generation of cathode materials is scarce and requires to be replaced with organic electrodes [2] to help address environmental issues and enhance gravimetric electrochemical capacity. The organic electrodes offer active materials that are based upon the elements C, H, O, N, and S, which are earth abundant. Recently, several biomass (renewable) precursors for activated carbon (AC) have received wide attention [3].

Preliminary research at Murdoch University has suggested that organic composites (for example hemp, natural honey dew peel, and eggshell-derived composites) are promising replacements for conventional AC precursors. Although a variety of carbon materials have been trialled in energy storage, hemp and other stated composites, synthesised by a simple one-step process with restricted functional groups, is novel and may produce an advanced storage material with higher performance. The AC derived from hemp precursor can make a huge gain in solving the real challenge of aqueous batteries and supercapacitors, which lie at the interfaces between electrodes and electrolytes. The SEM images (Fig. 1) of hemp show unique pores with high surface area (1195 m^2/g having 0.23 cm^3/g) resulting in typical electrochemical double-layer behaviour (Fig. 1 CV curve). The cyclic voltammetry (CV) rectangular curves of the AC from modified hemp are superior to that of commercial AC.

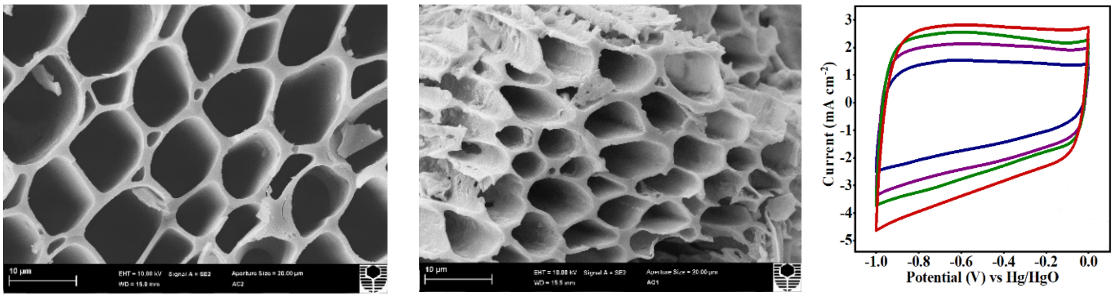

Figure 1 SEM images under different magnifications, and cyclic voltammetric (CV) curves of AC from hemp showing ordered pores and rectangular redox curves

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Quinone-based Lightweight Organic Rechargeable Batteries: Analysis for Working Mechanism, and Oligomerization for Long Cycle-life

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To develop a light-weighted and high gravimetric energy density battery, the use of redox active organic compounds would a promising option. We have reported a series of quinone-based materials showing high capacities. There are many unsolved issues related to the charge/discharge mechanism. In addition, it is often difficult to satisfy both the high capacity and long cycle-life, which hinders the practical application of these organic compounds. Regarding the charge-discharge mechanism, XRD and TEM has been used as tools to analyze the conventional minor-metal-oxide-based materials; however, these techniques are sometimes not suitable for the analysis of organic compounds. Therefore, we have used EDX [1], EELS [2], ion chromatography [3], ^{7}Li-NMR [4] to analyze charge carriers. Chemical structure change during the charge/discharge reaction can be analyzed by using ^{1}H-NMR [2], Raman, ESR, XAS, and SQUID magnetometer [4]. As for the ionic/electronic conduction mechanism, we have recently applied a solid-state NMR besides an impedance analysis and theoretical calculations. For degradation analysis, in addition to the color change analysis for the electrolyte solution including UV-vis spectroscopy, the EDX and Raman measurements can be powerful tools. To extend the cycle-life, oligomerization of redox centers is effective [5,6]. Recently, we suggested a high-capacity active material, phenazine-1,4,6,9-tetrone (PTO) [7], which shows more than 600 mAh/g, although there is room for cycle-life performance. For this drawback, we synthesized a few oligomers and found some improvement in the cycle-life performance.

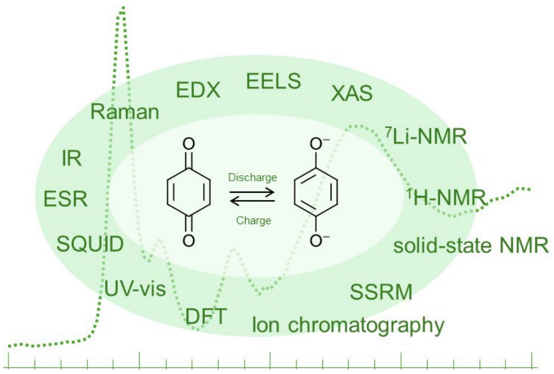

Figure: Various techniques for analysing the charge/discharge mechanism of quinone-based organic cathode compounds.

This presentation will cover the details of some analysis techniques as well as our recent progress in new compounds.

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Masaru Yao received his Ph.D in organic physical chemistry in 2005. During the Ph.D. course, he was engaged in the study of the Langmuir-Blodgett film and molecular magnetism. He then started the research activity about energy storage materials for use in nickel/metal-hydride batteries, lithium-ion batteries, and electric double layer capacitors at the National Institute of Advanced Industrial Science and Technology (AIST), Japan.

Stretchable Organic Redox Diffusion Battery for Wearable Power Source

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In response to the growing demand for batteries, research into organic batteries that utilize environmentally friendly and renewable resources has gained significant attention. Despite the additional benefits of biocompatibility and flexibility offered by organic materials, the development of stretchable organic batteries for wearable devices remains in its nascent stages. Previously, we demonstrated a stretchable organic battery by incorporating redox molecules into an elastic conducting polymer composite.[1]

More recently, our research group introduced a novel hybrid concept that bridges conventional batteries and redox flow batteries—termed the Redox Diffusion Battery (RDB).[2] The RDB is comprised of porous electrodes, redox molecule electrolytes that diffuse within these electrodes, and an ion-sieving membrane that separates the catholyte and anolyte while facilitating the transport of ions involved in the redox reactions. By fabricating each component in stretchable forms such as foam, gel, or elastomer, a fully stretchable RDB becomes achievable.

In this talk, we will present our latest advancements: an all-plant based stretchable ion-selective membrane that possesses good ionic conductivity (1 mS/cm), high stretchability (> 500%), and excellent prevention of electrolytes cross-over; and a highly conductive polymer fiber sponge designed for stretchable porous electrodes. These developments represent a promising step toward high-performance, sustainable, biocompatible power sources for next-generation wearable devices.

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Biography

Nara Kim received a BSc degree in Physics from Korea University in 2009 and a PhD degree in Materials Science and Engineering from the Gwangju Institute of Science and Technology in 2016 (PhD Supervisor: Prof. Kwanghee Lee). She joined the Laboratory of Organic Electronics at Linköping University as a postdoctoral researcher in 2017 and became an Assistant Professor in 2021 after receiving the Swedish Research Council (VR) Starting Grant. Her research interests include the structure–property relationship of mixed ion-electron conducting composites and their applications in wearable energy harvesting/storage devices and bioelectronic devices.

Understanding the Performance Discrepancies of Organic Electrodes in Lithium and Magnesium Batteries

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Redox-active organic electrodes, when coupled with high-energy-density metal anodes like lithium and magnesium, offer a promising pathway toward a sustainable energy future. However, the exact mechanisms governing their operation at the active particle level remain inadequately understood. Organic materials typically underperform in multivalent electrolytes, exhibiting lower capacities, higher overpotentials, and worse rate capabilities.[1,2] In this work, we propose a novel chemisorption mechanism that addresses the underlying causes of these performance discrepancies, using linear organic polymers (imide-based and anthraquinone-based) in both Li and Mg electrolytes.

Through systematic impedance experiments and transmission line modeling, we reveal that in Li-based systems, the electrochemical storage reaction is the limiting factor. At the same time, ion transport issues dominate in Mg-based systems. Our model is supported by various techniques, including conductivity measurements, experimental and theoretical charge/discharge analysis, high-resolution EDX mapping, solid-state NMR, and DFT calculations. These results provide a comprehensive framework that bridges processes across different time scales, laying the foundation for future investigations into organic electrode performance in diverse battery chemistries, with a particular focus on the challenges of multivalent systems.

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Biography: Olivera Lužanin is a postdoctoral research associate in the Modern Battery Systems Group at the National Institute of Chemistry. Her research focuses on gaining a fundamental understanding of the parameters that govern charge transfer reactions in organic electrodes paired with multivalent charge carriers.

Flexible Thermally Conductive Polymer Nanocomposites Films for Effective Battery Thermal Management

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Battery thermal management (BTM) materials are essential for ensuring safe efficient operation of batteries. However, it remains a great challenge to develop flexible thermally conductive polymer films as BTM materials due to poor flexibility, unsatisfactory cooling efficiency and lack of preheating capability. Herein, we report a low-cost scalable mechanically robust polymer nanocomposite film for lithium-ion batteries (LIB) by layer-by-layer assembly of carbon nanotubes, graphene nanosheets and waterborne polyurethane. As-prepared polymer nanocomposite film (WPU/CNTs1/GNP1) shows a high in-plane thermal conductivity (λ) of around 24.0 W m^{-1} K^{-1} and an out-of-plane λ of ~1.8 W m^{-1} K^{-1}. The WPU/CNTs1/GNP1 film demonstrates excellent foldability or flexibility, a desired cooling efficiency for LIB, and an ability to preheat the LIB, outperforming the commercial thermally conductive films and heating mats. This work provides a low-cost scalable solution to developing high-performance BTM materials, thus holding great potential for their real-world applications in energy storage field.

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Biography

Prof Dr Pingan Song received his Ph.D. from Zhejiang University in 2009. He is a Fellow of Royal Society of Chemistry (FRSC), and currently a full professor and Associate Head of School (research) at the School of Agriculture and Environmental Science of University of Southern Queensland, Australia. His research interests involve fire retardants, and polymers and polymer composites as well as their processing-structure–property correlations.

Redox Properties of Viologens Featuring Double Zwitterionic Skeletons for p-Type Electrode Applications

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Since their initial discovery in the 1930s by Michaelis and Hill, viologen derivatives (1,1'-disubstituted 4,4'-bipyridinium salts) have emerged as a versatile and influential class of compounds, valued both as synthetic building blocks and for their functional applications across various domains of chemistry. Owing to their strong electron-accepting character and well-defined redox behavior, viologens have become key components in supramolecular systems, particularly in the design of molecular machines such as rotaxanes and pseudorotaxanes. Their ability to undergo three fully reversible redox states ($V^{2+} \rightleftharpoons V^{\bullet+} \rightleftharpoons V^0$) has made them the subject of extensive electrochemical investigations. Notably, their distinct 4,4'-bipyridinium scaffold imparts a low redox potential compared to other p-type redox-active systems, rendering them particularly attractive for applications as negative electrode materials in all-organic anionic-based batteries. A variety of viologen-based electrode materials have been reported in non-aqueous media, including linear and cross-linked polymers[1-4], covalent organic frameworks[5], and crystalline host structures based on disalts of doubly zwitterionic organic frameworks[6]. This presentation will focus on this latter and less-explored class of crystalline viologen materials, highlighting their synthesis, structural characterization, and the electrochemical properties related to anion uptake and release.

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Biographies:

Birgit Esser is Full Professor of Organic Chemistry at Ulm University, Germany. After her Ph.D. (2008, University of Heidelberg, Germany) and postdoc (Massachusetts Institute of Technology, U.S.A.), she started her independent research group at the University of Bonn, Germany, as Liebig and Emmy-Noether fellow. In 2015 she became Associate Professor for Molecular/Organic Functional Materials at the University of Freiburg, Germany, and moved to Ulm University in 2022. Her research focusses on organic electrode materials for post-lithium batteries, hoop-shaped, conjugated π-systems, and photo(redox) catalysis.

Philippe Poizot is Full Professor of chemistry at Nantes University (IMN-CNRS), has over 25 years of experience in electrochemical energy storage. After a postdoctoral fellowship at the University of Missouri-Rolla (USA), he became Associate Professor at LRCS-CNRS in 2002, collaborating with Prof. J.-M. Tarascon. In 2007, he proposed the concept of "sustainable" batteries by promoting novel electrode materials based on redox-active organic compounds. In 2022, he was appointed co-director of the IMNBlue Lab, a joint laboratory between IMN and the French battery manufacturer BlueSolutions, which aims to develop GEN4 all-solid-state lithium metal batteries.

Advanced aqueous zinc-iodine batteries for energy storage

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Aqueous zinc batteries (AZBs) have emerged as a promising alternative to lithium-ion batteries for large-scale energy storage, owing to their inherent safety, low cost, and environmental friendliness. Among them, rechargeable zinc-iodine ($Zn-I_2$) batteries, which rely on the reversible conversion between I^- and I_2, have attracted particular attention due to their high redox reversibility, fast reaction kinetics, and the natural abundance of iodine. However, the dissolution of intermediate polyiodides during cycling leads to severe shuttle effects, causing active material loss and capacity fading. Additionally, the Zn anode suffers from issues such as dendrite growth and parasitic hydrogen evolution during Zn plating/stripping, which severely deteriorate Zn reversibility and shorten battery lifespan.

In this talk, I will introduce our recent progress in tackling these challenges through the rational design of functional host materials for iodine confinement, electrolyte engineering to suppress side reactions, and Zn anode modifications to enhance reversibility. Furthermore, I will present our successful demonstration of industrial-scale prototype cells and discuss the critical parameters of both the cathode and anode that affect the battery energy density, providing insights into the design principles for high-performance $Zn-I_2$ batteries. To further improve energy density, I will also introduce our recent findings on a novel four-electron $I^-/I_2/I^+$ redox conversion chemistry and evaluate its practical feasibility in real-world applications. These advancements offer new perspectives for the development of next-generation $Zn-I_2$ batteries with enhanced stability, efficiency, and scalability.

Biography

Dr. Shaojian Zhang received his master's degree from Xiamen University in 2019. He obtained his PhD degree from the University of Adelaide under the supervision of Prof. Shizhang Qiao in 2025. Currently, he is an ARC-Grant Funded Researcher in the University of Adelaide, which his supervisor is Prof. Shizhang Qiao. His research focuses on the development of advanced aqueous Zn batteries for energy storage. He has published over 50 peer-reviewed papers (15 as the first or co-first author), garnering more than 3300 citations and achieving an h-index of 29 on Google Scholar.

Spectator cation effect on bipolar Q-TTF-Q

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The spectator cation effect was initially discovered on n-type *p*-DHT derivatives, leading to high-potential lithiated positive electrode materials (OEM). When compared to $Li_2(Li_2)$-*p*-DHT,[1] swapping the lithium ions on the carboxylate groups for magnesium or zinc ions in $Mg(Li_2)$-*p*-DHT[2] or $Zn(Li_2)$-*p*-DHT[3] resulted in a shift for the average redox potential of the quinone moieties of +850 mV. While maintaining the negative charges of the carboxylate functional groups which prevent or limit the dissolution phenomenon of the OEM in carbonate-based electrolytes, these high ionic potential divalent cations also strongly affect the electronic density of the redox active functional groups.

Despite these pioneering results, the effect of spectator cations was not investigated on other OEM families to the best of our knowledge. This effect was therefore here investigated on derivatives of Q-TTF-Q, a bipolar OEM previously investigated in Li, Na and K batteries.[4] Q-TTF-Q possesses 2 quinones moieties corresponding to 4 reversible electrons in a n-type system, as well as a TTF bridge for 2 additional electrons in a p-type system. The reduced form of Q-TTF-Q, (Li_4)[HQ-TTF-HQ], was hence synthesized and investigated, and used for the preparation of (Li_2,Zn)[HQ-TTF-HQ] with Zn^{2+} as a spectator cation. The effect of Zn^{2+} on the electrochemical performances of this bipolar OEM will be discussed in this presentation.

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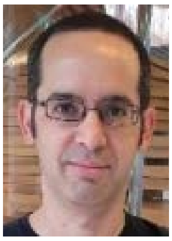
Biography



Stéven Renault is Associate Professor at Nantes Université (CNRS-IMN, France). After his Ph.D. on medicinal chemistry and drug design for a new treatment for Alzheimer's disease (Université de Rennes 1, 2007), he then worked on organic batteries in Université de Picardie Jules Verne (Amiens, France), in Uppsala University (Sweden), and in Nantes Université, which he joined in 2018. Along with Philippe Poizot, Franck Dolhem and Daniel Brandell, he co-organized the first Organic Battery Days meeting in Uppsala in 2017.

Synthesis of naphthalenediimide (NDI) based organic cathodes for enhancing capacity

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Polymer-based organic cathode materials offer a promising alternative to conventional inorganic cathodes by addressing cost and environmental concerns. Additionally, they mitigate the solubility issues commonly observed in small-molecule organic cathodes when exposed to electrolytes. Among these, conjugated polymers stand out due to their superior electrical conductivity, making them well-suited for fast charge-discharge processes. In this study, we synthesized naphthalenediimide (NDI)-based n-type conjugated polymers with varying molecular weights and investigated their impact on Li-metal battery performance. A systematic evaluation of their mechanical, physical, and optoelectronic properties allowed us to establish correlations with electrochemical behavior. Furthermore, we strategically modified the side chains and conjugated backbones to enhance the theoretical capacity of the cathodes, achieving an approximately 1.5-fold increase. Our findings underscore the potential of n-type conjugated polymers as high-performance organic cathode materials, contributing to the advancement of sustainable energy storage technologies.

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Biography (10pt, one paragraph with a headshot)
Dr Wonho Lee is an associate professor in the Department of Polymer Science and Engineering at Kumoh National Institute of Technology (kit). He received his Ph.D. degree in Chemical and Biomolecular Engineering from Korea Advanced Institute of Science and Technology (KAIST) in 2017. He also worked with Dr. Enrique D. Gomez as postdoctoral researcher at Penn State until 2019. His research interests are development of polymeric and inorganic materials for applications in organic optoelectronics devices and solid state Li metal batteries.

Solid-State Electrochemistry of Conjugated or Nonconjugated Radical Polymers for Energy Storage

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Aiming to address the potential supply shortage of battery metals like lithium, cobalt and nickelx, organic batteries using organic redox compounds as electrode materials emerged as an alternative for LIBs in recent years.[1] Radical polymers, notably poly(2,2,6,6-tetramethyl-piperidinyloxy-4-yl methacrylate) (PTMA), have been considered as a benchmark for organic cathode materials owing to their high output voltage and fast redox kinetics.[2] However, limited active mass loading restricted the development of radical polymer cathode materials because of their aliphatic main-chain, leading to high solubility in electrolytes and low conductivity.[3]

To address the inherent defects of aliphatic radical polymers, some recent studies concentred on conjugated radical polymer (CRP) with conjugated backbone (e.g. polypyrrole, polythiophene or polyacetylene) and stable radical pendants.[4-6] Conjugated backbone could offer efficient long-range charge transport compared to aliphatic main-chain, moreover, its rigidity also limits their solubility in various solvents. However, due to the reactive radicals, highly efficient synthesis of CRP remains elusive to date, which inevitably limited deep understanding of the relationship between their structure and electrochemical properties and even their energy storage performance is less investigated.

Here, we report a novel CRP, poly(p-phenylene ethynylene) (PPE) with pendant 2,2,6,6-tetramethylpiperidinyl-1-oxyl (TEMPO) radicals designated as PPE-TEMPO.[7] Compared the electrochemical behaviour and energy storage performance of PPE-TEMPO with PTMA, we reveal that the rigid and conjugated backbone of PPE-TEMPO promotes the charge transportation and counterion diffusion, helping us comprehend the structural factors of radical polymer affecting their final energy storage performance for lithium organic batteries.

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Enabling Rechargeable Aluminium-Organic Batteries

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Rechargeable aluminium batteries (RABs) using metallic Al anodes have emerged as a promising "post-lithium-ion" battery technology, because Al anodes can provide high capacities (2980 mAh g^{-1} and 8040 mAh cm^{-3}) with low cost and good safety. RAB research has seen rapid development, focusing on high-capacity cathodes. P-type organic cathode materials such as polycyclic aromatic hydrocarbons, undergoing oxidation to form positively charged radical cations and bind anionic charge carriers, exhibit high discharge potentials (>1.5 V), but suffer from low specific capacities, due to the apparent one or less than one electron redox processes.

We recently demonstrated a compromised electron-donating substitution strategy to excite 1-aminopyrene, a pyrene derivative, to undergo two-electron transfer, achieving a high specific capacity of 212 mA g^{-1} and excellent rate/long cycling performances, superior to reported organic RAB cathodes. Systematic investigations of pyrene derivatives revealed that the amino group exerts dual effects: facilitating electron removal from neutral molecules while reducing charge density in oxidized radical cations. 1-aminopyrene, optimized through this strategy, exhibits the highest charge-carrier binding energy and stable voltage within the electrolyte threshold, enabling efficient two-electron redox activity for high capacity.

We further investigated the current-dependent interfacial evolution at the electrified Al anode/electrolyte interface to elucidate the conditions that govern solid-electrolyte interphase (SEI) formation and its contribution to irreversible cycling in RABs. Our findings reveal that both resting and cycling conditions critically influence the electrochemical behaviour of the Al anode. These conditions determine not only the nature of the SEI but also the overall reversibility of Al plating/stripping, thereby directly affecting the long-term cycling stability of RABs.

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Biography (10pt, one paragraph with a headshot)

Dr Xiaodan Huang received his Bachelor (2007) and PhD (2012) degrees in Chemistry from Fudan University, China. He is currently an ARC Future Fellow at The University of Queensland, Australia. His research interests focus on the design and synthesis of novel nanostructured materials for applications in energy storage and environmental protection.

Organic molecular promoters in rechargeable batteries

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Organics and inorganics are the two sides of a coin of materials. The tunable chemical structures of organic molecules allow for customization to optimize conductivity, cycling stability, and environmental sustainability, thus promoting the overall performance of batteries and other energy devices as organic molecular promoters. Organic molecular promoters are particularly valuable in emerging battery technologies, such as active metal-ion batteries. In this presentation, I report our recent progress in applying organic molecular promoters to enhance the performance of Zn and Li-ion batteries. A specific focus on supressing the challenges in current batteries, such as dendrite growth, low operation voltage window, self-corrosion, etc., through the addition of organic molecular promoters into the components of either electrodes or electrolytes. The applications of organic molecular promoters in rechargeable batteries are significant, because they enhance electrochemical performance, improve energy efficiency, and extend battery lifespan. Organic molecular promoters help mitigate issues such as electrode degradation and polysulfide shuttling, ultimately contributing to more sustainable and high-performance energy storage solutions.

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Charge transfer and storage in novel materials for organic radical batteries

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Nowadays organic batteries are among the most promising approaches in energy storage, e.g. due to their rapid charging, mechanical flexibility and sustainability.[1] Conjugated polymers were initially widely investigated in the scope of such organic batteries.[2] However, an unstable cell voltage over the desired capacity range prevents their broad application.[3] Alternatively, stable organic radicals such as the tetramethylpiperidinyl-N-oxyl radical (TEMPO) show highly promising properties,[4] yet lacking the desired conductivity.

In this joint synthetic-theoretical contribution, a new approach by combining stable N-oxyl-based organic radicals with a conductive polymer-based backbone is presented. Particular emphasis is set on the quantum chemical and molecular dynamical modelling of intra- and intermolecular charge transfer (CT) processes as well as of the charge storage (CS) capabilities of these materials.[5,6,7] Several key properties were explored and how they affect the CT and the CS. Firstly, the influence of the chemical nature and length of the linker connecting the organic radical and the aromatic backbone was investigated.[5] Thereby, the focus was set on the already well characterised organic radical TEMPO in combination with an aromatic polythiophene backbone. Secondly, the influence of the type of the surrounding electrolyte was taken into account. Finally, the impact of the type and the ratio of the organic radical and the aromatic backbone subunits on the CT and CS was investigated.[5] Based on these considerations the dependencies of the electronic communication as well as the thermodynamic properties and hence the CT rates and the CS capacities on the structure of these organic radical system were revealed. These in-depth insights allow to tailor new organic radical batteries with optimal CT and CS properties. Very recently, this theory-driven approach led to the battery fabrication from this new class of organic radical batteries with conducting backbone.[7]

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Clara Zens is a PhD Student in her final year in the field of theoretical chemistry at the Friedrich Schiller University Jena. During her PhD in the quantum-chemistry junior group of Dr. Stephan Kupfer she is delving about the theoretical modelling of potential materials in the context of energy conversion and storage, e.g., organic radical batteries. Previously she completed her master’s and bachelor’s degree in the group of Prof. Neugebauer, researching about organic nanoparticles and CO releasing molecules by means of Raman and IR spectroscopy, respectively (both FSU Jena).

Modified carbon black and NMC for improved lithium-ion battery performance

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Lithium-ion batteries (LiBs) are the predominant commercial form of rechargeable batteries, and their performance relies on the effectiveness of the cathode which can influence its capacity, lifespan, and charging rate. This talk will focus on improving the performance of both the conductive additive, carbon black (CB), and the active material, nickel manganese cobalt oxide (NMC), in the cathodes of LiBs. By modifying CB with carbonyl moieties, the energy barrier for lithium-ion movement at the electrode-electrolyte interface was shown to be reduced, resulting in lower overpotentials and faster charge/discharge reactions.

In addition, NMC particles were modified with nanolayers of an iron-based metal phenolic network (MPN) with electrochemical impedance spectroscopy (EIS) showing improved lithium-ion accessibility to the NMC. This accessibility improves electrochemical kinetic processes within the cathode electrode, achieved through (1) improved passage of the ions in the electrolyte that penetrates the porous electrode structure (ionic transport), (2) improved passage of the ions through the cathode-electrolyte interphase, (3) improved charge-transfer reactions, and (4) improved passage of the ions in the NMC (solid-state diffusion). As a result, the cathode electrode showed reduced interfacial resistance and a more efficient NMC structural phase transition, with uniform (de)intercalation of lithium-ions on the surface. Overall, the chemical modifications of the CB and NMC lower the battery overpotential and thus the battery energy requirements, resulting in more efficient batteries.

D. Park, P. C. Sherrell, F. Xie, A. V. Ellis, *J. Mater. Chem. A* **2024**, 12, 4884.
D. Park, S. Shin, P. C. Sherrell, B. Roy, K. L. Callaghan, F. Caruso, A. V. Ellis, *Adv. Funct. Mater.,* **2024**, 2417549

Biography (10pt, one paragraph with a headshot)

Mr Donghyuck Park is currently a Ph.D. candidate at the University of Melbourne in the Department of Chemical Engineering under the supervision of Prof. Amanda V. Ellis. His PhD is working on the optimization of the cathode/electrolyte interfaces in lithium-ion batteries.

Solvent-free extrusion of polymer electrolytes for high voltage all solid-state batteries

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The demand for electric vehicles highlights the need to improve the performance of Li-Ion Batteries (LIBs), and to produce high-power, compact and safe batteries. Solid-State Batteries (SSBs) are therefore being widely investigated, as the use of a lithium metal anode and a thin layer of solid electrolyte provides access to high energy densities [2] and reduced dendrite growth [2]. Solid Polymer Electrolytes (SPEs) are promising as they favor interfaces with electrodes [3], a major challenge for SSBs [4].

However, SPEs prepared at the laboratory scale usually involve solvents during processing, which can be difficult to remove, and degrade upon cycling. In this work, we developed a solvent-free extrusion protocol to produce self-standing membranes of polycarbonate-based polymer electrolytes and cathodes. We used different lithium salts, including Single-Ion-Conducting-Polymers (SICP) and organic compounds, to optimize the ionic conductivity of the electrolytes. Thermal analyses were carried out (TGA, DSC) to evaluate the thermo-mechanical properties of the compounds and films, in order to fine-tune the extrusion protocol and prevent degradation during extrusion. Infrared Spectroscopy (FTIR) was used to ensure the homogeneity of the extruded membranes, and the ionic conductivities of the electrolytes were measured by Electrochemical Impedance Spectroscopy (EIS). High-Voltage cathodes were extruded by incorporating NMC 811 and conductive carbon into the SPEs. Coin cells were assembled using a double-layer SPE setup, and the electrochemical performance was tested.

In this work, an emphasis is placed on the processability of the films and their ability to self-stand, while unbiasedly exploring the achievable performance and limitations of such fully extruded solvent-free polycarbonate electrolytes and cathodes.

[1] X. Chen, X. Li, L. Luo, S. He, J. Chen, Y. Liu, H. Pan, Y. Song, R. Hu, Practical Application of All-Solid-State Lithium Batteries Based on High-Voltage Cathodes: Challenges and Progress, *Adv. Energy Mater,* **2023** 13, 2301230
[2] Zahra Moradi, Amirmasoud Lanjan, Ramavtar Tyagi, Seshasai Srinivasan, Review on current state, challenges, and potential solutions in solid-state batteries research, *Journal of Energy Storage,* **2023**, 73, 109048
[3] Song, Z., Chen, F., Martinez-Ibañez, M. et al. A reflection on polymer electrolytes for solid-state lithium metal batteries. *Nat Commun*, **2023,** 14, 4884
[4] Teddy Mageto, Sanket D. Bhoyate, Felipe M. de Souza, Kwadwo Mensah-Darkwa, Anuj Kumar, Ram K. Gupta, Developing practical solid-state rechargeable Li-ion batteries: Concepts, challenges, and improvement strategies, *Journal of Energy Storage*, **2022**, 105688

My name is Florian Léveillé, I am a 3rd year French PhD student. In 2022, I obtained a Master "Polymer and Surfaces" from the University of Rouen, Normandy, France. My PhD is part of an U.E. project called PSIONIC, aiming at producing high voltage polymer based all-solid-state batteries. My work focuses on combining polymer extrusion and characterization with electrochemical tests to explore the performance of polymeric films as electrolytes and cathodes.

Optimising the electrochemical performance of manganese (II, III) oxide for lithium-ion battery anodes

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Manganese oxides have attracted significant interest as energy storage materials. Mn_3O_4 has a higher theoretical capacity (936 $mAhg^{-1}$)[1] than that of natural graphite (372 $mAhg^{-1}$)[1] which is traditionally used as an anode material in lithium-ion batteries. Mn_3O_4 also has a lower voltage hysteresis (<0.8 V) than that of MnO_2 and it is non-toxic to the environment.[1,2] However, Mn_3O_4 anodes suffer from poor conductivity ($10^{-7} – 10^{-8}$ S m^{-1}) and slow ion diffusion rates.[1] In this work, Mn_3O_4 particles are synthesised using a solvothermal synthesis method in the presence of graphene oxide. The resulting Mn_3O_4/reduced graphene oxide (rGO) hybrid anodes demonstrate significant improvements in capacity, cycling stability and rate capability compared to Mn_3O_4. The Mn_3O_4/rGO hybrid anode has a higher discharge capacity (531 $mAhg^{-1}$) compared to Mn_3O_4 (332 $mAhg^{-1}$) after the rate performance experiment. In this talk, helium ion microscopy (HIM) images, galvanostatic charge-discharge results, impedance data and ion diffusion rates are discussed.

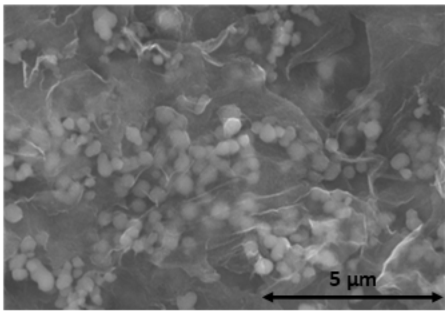

Figure 1 – Scanning electron microscopy image of Mn_3O_4/rGO. Accelerating voltage = 20 kV. Magnification = 10k.

References

1. Chen, J.; Hu, X.; Gao, H.; Yan, S.; Chen, S.; Liu, X, *Journal of Materials Science & Technology* **2022**, 99, 9-17.

2. Chen, J.; Bai, Z.; Li, X.; Wang, Q.; Du, J.; Lu, R.; Liu, X, *Ceramics International* **2022**, 48, 31923-31930.

Biography

Lucy McElhone was awarded a First Class Master's degree with honours in Chemistry (MChem) from Newcastle University (United Kingdom) in 2020. She is currently a final year PhD student on the Manchester-Melbourne dual award PhD programme between the University of Manchester (United Kingdom) and the University of Melbourne (Australia). Her research involves lithium-ion battery anodes, nanomaterials and electrochemistry.

Molecular-based conductive active material for metal-ion batteries

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Utilizing organic materials in battery technologies provides numerous advantages, including enhanced durability and cost-effectiveness related to the abundance of their constituents. Nevertheless, in the current development of batteries, these electro-active materials encounter a major challenge: their electronic conductivity. The deficiency in conductivity leads to low electrochemical performances and requires a high amount of conductive carbon (20-60 wt%). This high amount of additive lowers the quantity of active material in the electrode and diminishes drastically the energy density. Over the past decades, various strategies have been explored in order to face this challenge, such as organized molecular systems[1,2] or metal-organic active materials[3]. Very recently, charge transfer complexes based on TTF-TCNQ[4] has also been investigated as electroactive material and has gained attention for their high electronic conductivity up to 300 S/cm. In this context, our work focuses on the development of new molecular redox active materials for ion batteries with high electronic conductivity to lower the amount of carbon additive and maximize storage performances. In such approach, we had a look at radical salt generated by electro-crystallization and presenting an electronic conductivity reaching 0.05 S/cm at 300 K. Galvanostatic cycling and full material characterization are in the center of the study. A specific attention has been paid to advanced characterization of the material at different state of oxidation/reduction such as X-ray *operando* and *ex-situ* analysis to investigate the behavior of this new active material in batteries.

1 V. Pignier, S. Toumieux, C. Davoisne, M. Caroff, A. Jamali, S. Pilard, D. Mathiron, D. Cailleu, F. Delattre, D. P. Singh, R. Douali and M. Becuwe, *Small*, 2023, 2305701.
2 É. Deunf, P. Moreau, É. Quarez, D. Guyomard, F. Dolhem and P. Poizot, *J. Mater. Chem. A*, 2016, **4**, 6131–6139.
3 C. Fang, Y. Huang, L. Yuan, Y. Liu, W. Chen, Y. Huang, K. Chen, J. Han, Q. Liu and Y. Huang, *Angew Chem Int Ed*, 2017, **56**, 6793–6797.
4 Y. Fujihara, H. Kobayashi, S. Takaishi, T. Tomai, M. Yamashita and I. Honma, *ACS Appl. Mater. Interfaces*, 2020, **12**, 25748–25755.

Biography

I recently earned a master's degree in materials chemistry from the University of Montpellier (France) in 2023. Since then, I have been pursuing a PhD at the Laboratory of Reactivity and Chemistry of Solids (LRCS) in Amiens. My research focuses on the electrochemical and structural properties of organic charge-transfer complexes, which have promising conductivity for energy storage applications.

Hierarchical Modelling of Redox-Active Polymers for All Organic Batteries

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Redox-active polymers (RAPs) offer a promising path toward realizing all-organic batteries, presenting a metal-free alternative to energy storage systems. These materials, comprising non-conjugated organic backbones with stable radical side ~~-~~groups, possess an extensive design space that remains largely unexplored. To address this gap, we present a hierarchical computational modeling framework that combines atomistic molecular dynamics, electronic structure calculations and machine learning surrogate models to link bottom-up molecular characteristics and macroscopic properties such as apparent diffusion coefficients of electron transport [1].

We investigate the impact of backbone structure, state of charge and polymer swelling on electron transport in two promising RAP materials: phthalimide-containing polymers for anodic applications and phenothiazine-cont~~r~~aining polymers for cathodic use. Our findings reveal that the state of charge significantly influences solid-state packing and thermophysical properties, which in turn, affect ionic and electronic transport. A combination of molecular-level properties and condensed-phase properties determine the predicted ranking of electron transport capabilities of the polymers. Our framework predicts remarkable electron transport capabilities for both phthalimide and phenothiazine-based polymers, underscoring their potential as highly capable electrode materials in all-organic batteries. This work demonstrates the power of computational modeling in guiding the design and optimization of organic and polymer electrodes for next-generation sustainable energy storage systems.

[1] Alessandri, R.; Li, C.-H.; Keating, S.; Mohanty K.T.; Peng, A.; Lutkenhaus, J.L.; Rowan, S.J.; Tabor, D.P.; de Pablo, J.J., *JACS Au* **2024**, 4, 2300-2311

Biography

María is a PhD candidate at the Pritzker School of Molecular Engineering, University of Chicago, where she is advancing the field of sustainable energy storage through innovative computational approaches. Her research focuses on the numerical characterization of redox-active polymers (RAPs) for organic batteries, employing advanced modeling techniques to predict and optimize their properties.

Unlocking 4V-Class N-Type Organic Cathodes: The Potential of Conjugated Triflimides and Cyanamides

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Organic electrode materials have attracted significant interest due to their sustainability, cost-effectiveness, and structural tunability. However, the development of organic positive electrode materials with redox potentials exceeding 3 V vs. Li^+/Li^0, while maintaining air stability in a Li-reservoir configuration, remains a challenge. This study advances the field by introducing a new class of high-voltage organic Li-ion cathodes, leveraging electron-withdrawing group (EWG) functionalization to deplete electron density at the redox center via mesomeric effects. Specifically, we report the synthesis of conjugated triflimides and cyanamides, which exhibit remarkable ambient stability and reversible electrochemistry with redox potentials ranging from 3.1 V to 3.8 V vs. Li^+/Li^0—the highest recorded for n-type organic electrode materials. Through detailed structural characterization and electrochemical analysis, we establish the molecular design principles that enable fine-tuning of redox potentials. These findings pave the way for the next generation of high-voltage organic cathodes, bringing them closer to the performance of inorganic alternatives and promoting their integration into sustainable energy storage systems.[1]

References:
1. X. Guo, P. Apostol, X. Zhou, J. Wang, X. Lin, D. Rambabu, M. Du, S. Er, A. Vlad, Energy Environ. Sci. 2023, 17, 173.

Biography

I am currently doing a Ph.D. at Université Catholique de Louvain, specializing in high-voltage organic cathodes for divalent cation storage. My work focuses on developing sustainable and efficient electrode materials to advance next-generation energy storage systems. By exploring novel organic chemistries, I aim to bridge the gap between organic and inorganic battery materials, contributing to the transition toward more sustainable energy solutions.

Rechargeable Aqueous MOF–Manganese Batteries

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【Introduction】 Rechargeable aqueous manganese-based batteries have attracted significant attention due to environmental friendliness, their earth abundant components, low cost, and high theoretical capacity. However, state-of-the-art manganese-zinc batteries exhibit poor durability due to the dendrite formation on the surface of the zinc anode during repeated charging and discharging.[1] In other words, an anode-active material that can store charge with high durability (capacity retention close to 100%) is highly required.

In the current work, we prepared a redox-active metal-organic framework (**RAMOF**), Zr-based **UiO-66-(OH)$_2$**, which was structurally stable and achieved reversible charge storage with theoretical capacity even in acidic aqueous electrolytes owing to its small particle size, strong Zr–O bonds with high bond energy. We demonstrated a highly durable and rechargeable aqueous **MOF**–manganese battery and the material recycle of the **RAMOF** based on coordination bonds.

【Results and Discussion】

We synthesized **UiO-66-(OH)$_2$** by microwave irradiation. In addition, the **RAMOF** exhibited high durability (98% after 50 cycles) and high Coulombic efficiency (99%) owing to its high crystallinity and proton conductivity. As shown in **Figure**, a rechargeable aqueous **MOF**–manganese battery with the **RAMOF**/carbon composite electrode as the anode, MnO_2 as the cathode, and a 1 M $MnSO_4$ and 0.05 M H_2SO_4 aqueous electrolyte was fabricated. The battery exhibited high durability (99% after 50 cycles) and high Coulombic efficiency (99%), which indicated that using a **RAMOF** as an anode-active material overcame the weak point of manganese batteries. Furthermore, the **RAMOF** was decomposed based on coordination bonds with NH_4HCO_3 aqueous solution and reconstructed.

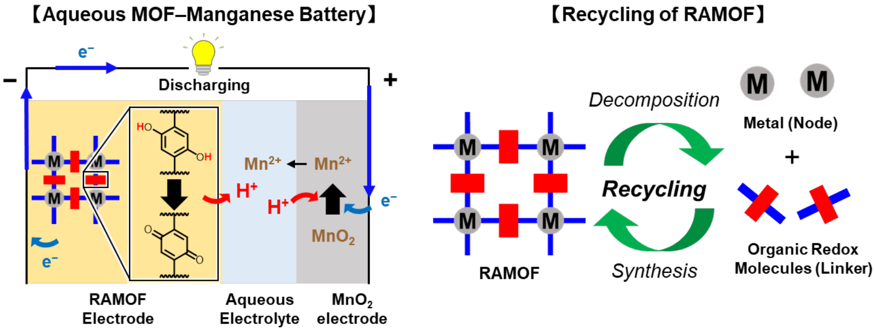

Figure. Aqueous MOF–manganese rechargeable battery

【References】

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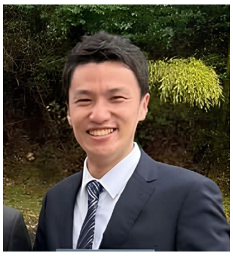
Biography



Ryota Akai

PhD student, Supervisor: Prof. Hitoshi Kasai and Prof. Kouki Oka, Tohoku University

Experience
2024-2025 JSPS Research Fellowship (DC2).

Awards
2022 Excellent Poster Presentation Award; JTBW on Nano-Science

Development of long-life and recyclable anthraquinone-based cathode carrying amide bonds

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To achieve a carbon-neutral society, utilizing secondary batteries is crucial. The batteries should meet many demands not only for high energy density and long life but also for recyclability and thermal stability. In response to these requirements, we have focused our attention on organic active materials. Their cycle performance is often hindered by issues such as dissolution in the electrolyte solutions; however, an oligomerization would be an effective strategy to overcome the dissolution issue. Recently, we successfully synthesized a dimer and trimer of anthraquinone (AQ) linked by amide bonds (Fig. 1a-c) which undergo hydrolysis so that these oligomers are suitable for recycling.[1]

This study focused on synthesizing an amide-bonded AQ polymer (Fig. 1d) to further enhance the cycle performance as organic cathode materials. Fig. 2 compares the cycle performance of the AQ monomer, amide dimer, trimer, and polymer. The AQ monomer showed a high initial discharge capacity and afterwards significant capacity loss: 11% of capacity retention after 100 cycles. In contrast, the AQ amide polymer exhibited 82% of retention and the highest capacity after 100 cycles, proving that the polymerization enhances the cycle performance. This finding will contribute to the development of organic rechargeable batteries, offering a promising step towards more sustainable, environmentally friendly energy storage solutions.

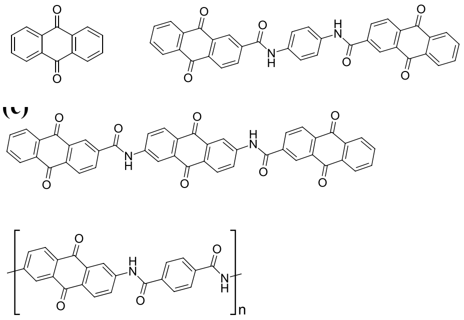

Fig. 1. Chemical formulae of (a) the AQ monomer, (b) AQ amide dimer, (c) AQ amide trimer, and (d) AQ amide polymer.

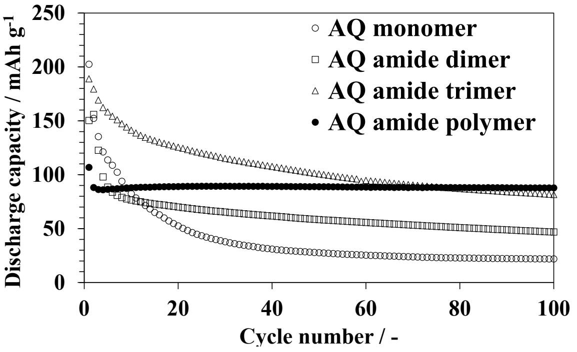

Fig. 2. Cycle performance of the cells using the AQ monomer, AQ amide dimer, AQ amide trimer, and AQ amide polymer.

1. M. Yao, H. Sano, H. Ando, *Polymers*, **2023**, 15, 4395.

Dr. Saki Fukuma is a researcher at the National Institute of Advanced Industrial Science and Technology (AIST), a national laboratory in Japan. She earned her B.S., M.S., and Ph.D. in Chemical Engineering from Okayama University, Japan. After working on practical battery research at a Japanese automobile manufacturer, she has been studying basic science of lithium secondary batteries and soft matters at AIST since 2022.

Charge-discharge mechanism analysis of a high-capacity organic cathode material: phenazinetetrone

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There is a growing demand for high-energy-density storage devices. The specific-energy density of current mainstream lithium-ion batteries (LIB) has almost reached their theoretical capacity limit, and the development of next-generation batteries using high-capacity materials based on a novel design is desired recently. Organic cathode materials, comprising an only light-weight atoms, has received a great attention as superior theoretical energy density materials. We have previously reported the synthesis of a new compound, phenazine-1,4,6,9-tetrone ($C_{12}H_4N_2O_4$: PTO, Fig. 1), and its high capacity of over 600 mAh/g[1]. However, the cycle-life performance of the PTO cathode was not sufficient, and the factor for the capacity degradation was clear. To identify the degradation factor of the PTO electrode, we investigated the charge/discharge mechanism of PTO through the analyses such as a dissolution test, XRD, and solid-state NMR in this study.

First, the crystallinity change of the PTO phase during the discharge process composed of three voltage plateau regions was investigated. The initial electrode gave a crystalline XRD pattern based on the π-stacked structure of the pristine PTO; however, the clear pattern disappeared after the discharge process. Then, we applied ^{1}H-NMR as an alternative method to analyze the structure. While PTO shows a single ^{1}H-NMR singlet in a solution measurement, solid-state NMR gave a split pattern reflecting the π-stacked structure in their powders (Fig. 2) [2]. These split peaks were also observed even in the discharged electrode indicating that the discharged PTO particles possess a short-range structure. We consider that conductive paths through π-stacked moieties in the particles are maintained during the discharge process. In the presentation, we will also report on the relationship between the solubility and capacity degradation.

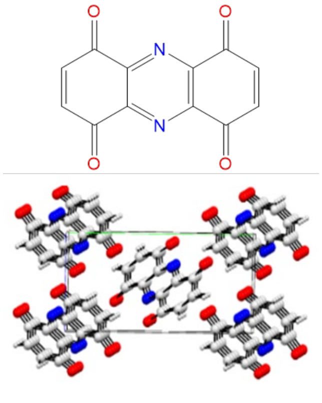

Fig. 1 Chemical and crystal structure of PTO.

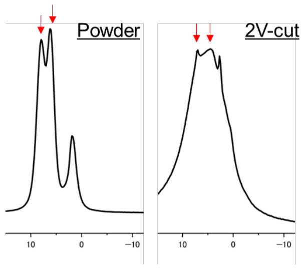

Fig. 2 Solid state ^{1}H-NMR spectral change for PTO.

[1] M. Yao, et al., *The 88th ECSJ Spring Meeting,* **2021** Abstract #: 1J23.

[2] Lin, C. et al., *BMC Chemistry,* **2020**, 14, 66

Shuntaro Miyakawa was born in Aichi, Japan in 1995. He received his master degree in materials science and engineering from the Univercity of Gifu, Japan. He is a battery material researcher at SoftBank corp. from 2020. He is also in the Ph.D. course in materials science at the Univiersity of Hokkaido.

Edible Rechargeable Batteries

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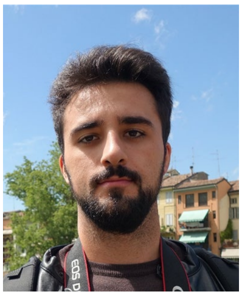
Edible rechargeable batteries represent a new opportunity for energy storage, currently dominated by toxic materials. Being entirely made of food-derived materials and additives, such batteries open the way to electronic systems characterized by unprecedented features. Their intrinsic safety and sustainability can be key in next-generation medical and agrifood low-power electronic devices, replacing traditional batteries and reducing health hazards and environmental impact.

The redox reaction between two molecules commonly found in food, riboflavin and quercetin, is exploited to develop an aqueous rechargeable organic battery with an operating voltage of ~0.65 V. All the battery components are fabricated using materials that can be safely ingested, like activated carbon, edible gold leaves, ethyl cellulose, nori, and beeswax. Edible battery stability has been extensively tested, showing a stable capacity of ~20 µAh over two weeks of storage at room temperature. The possibility of implementing these batteries in different scenarios has been verified by cycling them in various environmental conditions, proving stable performance between 0 and 37 °C. Successful integration with both traditional and edible electronic components has been achieved, indicating a feasible path to developing edible batteries as critical components in sustainable agrifood IoT nodes and power supplies in future edible electronic systems for medical and food monitoring applications.[1,2]

1. Ilic, Ivan K., et al. *Advanced materials* **2023,** 35.20, 2211400.
2. Galli, Valerio, et al. *Advanced Materials Technologies* **2024**, 2400715.



Valerio Galli was born in Milan in 1997 and received his B.Sc. and M.Sc. in Materials Engineering and Nanotechnology from Politecnico di Milano in 2019 and 2022, respectively. He developed his master's thesis during a nine-month internship at BeDimensional S.p.A. (Genova, Italy), working on 2D materials for electrochemical and electronic applications. In November 2022 he started a PhD in Physics at Politecnico di Milano, in collaboration with the Center for Nano Science and Technology – CNST (Istituto Italiano di Tecnologia). His research within the RoboFood EU project focuses on edible rechargeable batteries.

Synthesis of high redox potential quinolates for energy storage

Yannis Zekhenine,[1] Vincent Maurel,[2] Philippe Poizot,[3] Lionel Dubois,[2] and Thibaut Gutel[1]
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Positive electrode materials for Li-ion batteries lead to constraints of sustainability and resources, particularly due to the scarcity of cobalt and the toxicity of nickel. Organic active materials offer an interesting alternative through sustainable synthesis routes from the most abundant and available materials on earth.[1]

Dilithium (2,5-dilithium-oxy)-terephthalate salt (Li_4-*p*-DHT) has been reported as an organic electrode material with an average operating potential of 2.55 vs Li^+/Li.[2] The redox reaction at high voltage, while being totally reversible, involves only one electron corresponding to half its theoretical specific capacity of 220 mAh/g. The total specific capacity could only be attained by preparing nanosheets.[3] Isomerization of the redox moiety from hydroquinone to catechol gives a potential increase of approximately 300mV without altering the other electrochemical properties.[4]

Ion exchange with magnesium on lithium carboxylates also increases the potential up to 800mV with respect to Li_4-*p*-DHT. The so-called $MgLi_2$-*p*-DHT is then reported as an organic material with a potential of 3.45 V vs Li^+/Li and a reversible one-electron redox process at high potential for a capacity of roughly 100 mAh/g.[5]

As ten years of optimization still demonstrate the robustness and modularity of this structure, other Li_4-*p*-DHT analogues have been prepared. The synthesis routes and the electrochemical performances will be presented. This work is intended to complement the literature on the persistent phenomena of this class of molecules such as the electron limitation of the electrochemical process or the air stability in the reduced and lithiated state.

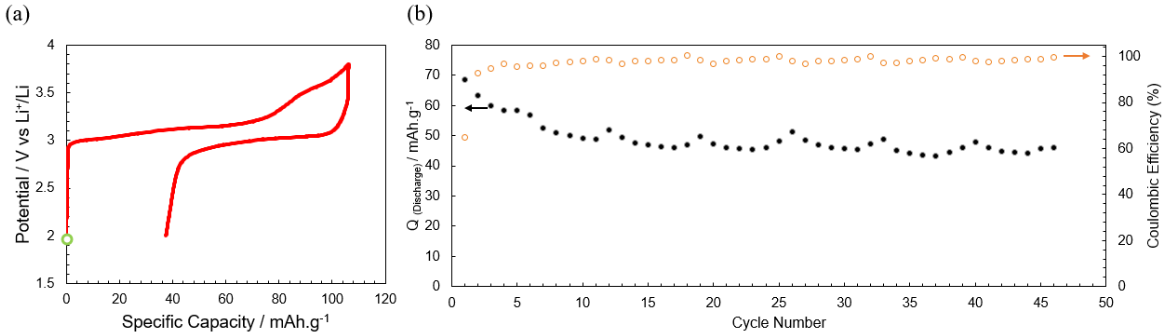

Figure 1. (a) First cycle of a Li half-cell using a novel Li4-p-DHT analogue as the positive electrode material (30 wt% of carbon additive) and galvanostatically cycled at C/10. Green circle indicates the starting potential. (b) Corresponding specific capacity in discharge and coulombic efficiency as functions of cycle number.

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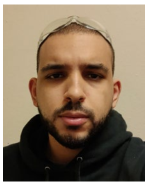
Biography



Yannis Zekhenine is a French PhD student at CEA-Grenoble attached to Université Grenoble-Alpes. Initially trained as an organic chemist, he completed his master's studies with an internship in molecular electrochemistry in 2023 at Laboratoire d'Electrochimie Moléculaire, Université Paris Cité. He is currently preparing a thesis on the synthesis of new organic electrode materials for lithium batteries.

Self-assembled fluoropolymer gel electrolytes for ultra-stable aqueous zinc-ion battery

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The growing demand for efficient and sustainable energy storage has driven extensive research into advanced electrolytes for aqueous zinc-ion batteries (AZIBs), a safer and more environmentally friendly alternative to lithium-based systems. However, unresolved challenges such as dendrite growth, causing short circuits and capacity loss, and poor electrolyte stability, which degrades battery performance and lifespan, continue to limit the application of AZIBs.[1] To address these issues, we present a novel fluorine-containing block copolymer gel electrolyte synthesized via UV-induced Reversible addition–fragmentation chain transfer (RAFT) polymerization. The photoinduced cross-linking forms a flexible three-dimensional network, while the polymer's amphiphilic design, featuring hydrophilic PEG segments and hydrophobic fluorinated blocks, induces self-assembly into distinct microphase-separated structures. These microstructures enhance ion transport and provide additional mechanical support for electrolyte.[2] Moreover, the fluorinated domains contribute to the formation of a robust, fluoride-rich solid electrolyte interphase (SEI), effectively suppressing side reactions and extending battery lifespan.[3] These synergistic effects not only mitigate dendrite growth but also enhance electrolyte stability, resulting in a several-fold increase in the cycling lifespan of symmetric cells and outstanding performance in full-cell configurations. These results demonstrate the effectiveness of our strategy in overcoming the limitations of traditional liquid electrolytes in aqueous zinc batteries. This innovative gel electrolyte design not only addresses the key limitations of aqueous zinc batteries but also offers a scalable and efficient strategy for advancing next-generation, sustainable energy storage technologies.

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Biography

Yiqing Wang began her Ph.D. journey in 2022 at Australian Institute for Bioengineering and Nanotechnology under the mentorship of Professor Andrew Whittaker and Dr. Cheng Zhang. Her research focuses on designing macromolecules with precise structures, particularly for applications in reversible aqueous zinc-ion batteries. Specializing in polymer chemistry, she explores the synthesis and characterization of well-defined polymers to develop advanced materials for next-generation energy storage devices.

Utilization of perfluorocarboxylic acids in rechargeable batteries

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Per- and polyfluoroalkyl substances (PFAS) are synthetic fluorinated organic compounds that are linked to severe health issues due to their environmental persistence and bioaccumulation. [1, 2] The urgent need for effective PFAS remediation strategies raises with these significant concerns. Current remediation strategies can be broadly classified into non-destructive and destructive methods.[3] The non-destructive method removes and isolates PFAS from the contaminated sources, however, high-concentration PFAS solutions generate from this method. Destructive methods are developed to treat these concentrated PFAS solutions by breaking the C-F bonds. However, such methods involve harsh degradation process, which are energy consuming and may release toxic gaseous by-products. Our work addresses the challenge of sustainably managing high-concentration PFAS solutions by combining sorption and utilisation strategy. In this work, we integrated PFAS into rechargeable battery systems that are under aqueous environment and room temperature. As one of the largest PFAS groups, perfluorocarboxylic acids (PFCAs) are successfully adsorbed onto the surface of zinc metal via hydrophobic interactions, enabling their application as an anode protective layer in aqueous batteries. Compared to bare zinc metal, the results highlight that this layer enhance electrochemical performance by supressing the dendrite growth and self-corrosion. In addition, the cycling stability of Zn|NVO full cells is also enhanced, demonstrating a prolonged and reliable performance. This work highlights the potential of metal based PFAS adsorption strategy, bridging the gap between sorption and utilisation, offering an innovative solution to transform this persistent water contaminant into valuable battery component.

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Biography

Yutong Zhu completed her bachelor’s degree at The University of Queensland (UQ), and is now a second-year PhD candidate at Australian Institute for Bioengineering and Nanotechnology (AIBN), UQ under supervision of Dr Cheng Zhang and Prof Lianzhou Wang. Her research focuses on PFAS remediation strategies including the removal of PFAS from aqueous solution using metals, and the utilizaiton of concentrated PFAS into rechargable battery systems.

All-plant-based stretchable ion-sieving separator for novel wearable electrochemical energy devices

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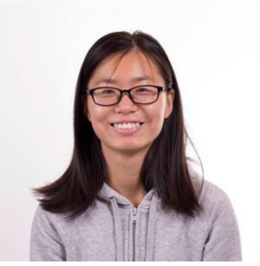
Comfortable interface intimately with the human body is becoming one of the most important parameters for the next generation of wearables. So far various types of stretchable energy storage devices have been developed. However, energy storage devices are experiencing serious problems, such as explosion risk, the usage of rare-earth metals and non-compatible materials. Hence, developing an environmentally friendly, safe and stretchable energy storage is imminent. While ion-sieving separators are a crucial part of those electrochemical energy storage devices, they decide and affect the softness/stretchability of the whole device. Hence, the big challenge for stretchable energy storage devices is fabricating a stretchable ion-sieving separator. Thus, we developed a plant-based, stretchable ion-sieving separator to advance the fabrication of wearable electrochemical energy devices.

Biography

Dr. Danfeng Cao is a Postdoctoral fellow in Linkoping University, specializing in on Plant based stretchable sustainable energy storage. With a Ph.D. in Applied Physics from Linkoping University.



Viscosity Response to Redox Reaction in Water-Soluble TEMPO-Substituted Polyacrylamide for Aqueous Redox Flow Batteries

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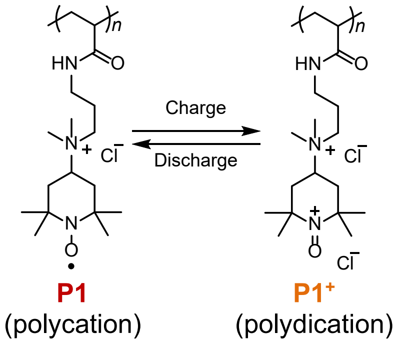
Application of polymeric active materials in redox flow batteries prevent permeation without the use of expensive ionic exchange membrane1). Poly(TEMPO-substituted acrylamide) with ammonium on the side chain (**P1**) exhibits high solubility while maintaining flowability compared to conventional water-soluble copolymers. It is a candidate for the cathode active material with the vanadium-class high capacity. Increased viscosity leads to pressure loss in pumps and reduced ionic conductivity. Evaluation of viscosity properties is a critical issue. In this study, dynamic viscosity and intrinsic viscosities behavior in response to redox reactions was analyzed from the viewpoint of polyelectrolytes. **P1** with different molecular weights were synthesized by controlling the concentration of monomers. For **P1** with molecular weight, $M_n = 1.4 \times 10^4$, the intrinsic viscosity of the oxoammonium-substituted polydication (**P1**$^+$) (3.6 mL/g) was reduced compared to the nitroxide radical-substituted polycation (4.8 mL/g) for electrolytes containing 1 M sodium chloride (**Scheme**, **Fig. 1**). In this presentation, the mechanisms of swelling and shrinking behavior in relation to the redox reaction will be discussed in detail.



Scheme

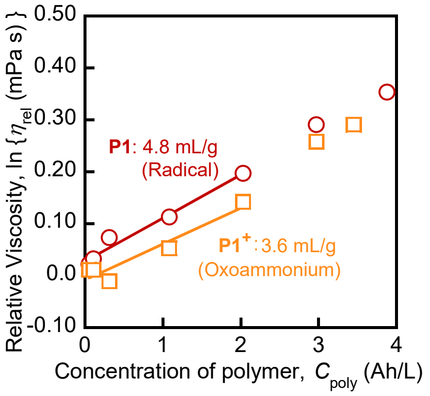


Fig. 1 Concentration dependence of viscosity of reduced (**P1**) and oxidized (**P1**$^+$) forms in 1 M NaCl aqueous solution.

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Biography

Kohei ISHIGAMI is a Ph.D. candidate in the Department of Applied Chemistry at the Graduate School of Advanced Science and Engineering, Waseda University, Japan. Concurrently, he serves as a research associate at the Faculty of Science and Engineering of Waseda University. He obtained his Master of Engineering in 2025 and Bachelor of Engineering in 2023 from Waseda University. His research focuses on organic redox flow batteries, particularly in polymeric active materials.

Electroactive Ligating Electrodes

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Organic electrodes are composed of abundant elements[1, 2] and may be accessible through biomass[1, 3] or green synthetic routes.[1-4] Furthermore, n-type organic electrodes, such as those based on carbonyl or imine containing frameworks, are compatible with the current commercial infrastructure.[1, 4] For this reason, efforts have been made to increase their redox potential towards 4 V(Li/Li$^+$)[1] to provide both greater energy density and greater stability against parasitic losses or auto-oxidation.[1, 4] Typically synthetic modifications, through the introduction of inductive or mesomeric electron-withdrawing groups, are employed to achieve a high reduction potential by lowering the energy of the lowest unoccupied molecular orbital (LUMO) of the compound.[1-3] Formation of a metal-organic framework (MOF) is another method by which the LUMO can be lowered. Metal ligation can provide an additional redox centre by which the energy density of the material can be increased.[1, 5] Moreover, MOFs avoid the polymorphism issues that typically prohibit elucidation of clear structure-property relationships, as well as providing a large surface area and pore-structure for high-capacity, high-rate battery operation.[5]

In this work, a class of so far unreported n-type organic electroactive ligands were synthesised from cheap and abundant starting materials and screened via electrochemical techniques to identify their electrochemical reversibility and stability. Density functional theory calculations were further used to support experimental work in both design and explanation of the physio-chemical phenomena observed. These compounds may hold much promise as tuneable electrical energy storage media and as a platform technology for further optimisation.

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Biography
Rajesh B. Jethwa received his Ph.D. in 2022 from the University of Cambridge under the supervision of Prof. Dame Clare P. Grey and Prof. Dominic S. Wright. His doctoral thesis focused on quinoidal compounds for use as redox flow battery electrolytes. Currently he is a Marie Skłodowska-Curie fellow at the Institute of Science and Technology Austria (ISTA) in the group of Prof. Stefan A. Freunberger. His interests lie in the molecular design of organic redox active species for energy storage applications.

Design Principles of Quinone Redox Systems for Advanced Sulfide Solid-State Organic Lithium Metal Batteries

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Université catholique de Louvain, Louvain-la-Neuve B-1348, Belgium
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The emergence of solid-state battery technology presents a potential solution to the dissolution challenges of high-capacity small molecule quinone redox systems [1]. Nonetheless, the successful integration of argyrodite-type Li_6PS_5Cl, the most promising solid-state electrolyte system, and quinone redox systems remains elusive due to their inherent reactivity [2]. Here, a library of quinone derivatives is selected as model electrode materials to ascertain the critical descriptors governing the (electro)chemical compatibility and subsequently the performances of Li_6PS_5Cl-based solid-state organic lithium metal batteries (LMBs) [3]. Compatibility is attained if the lowest unoccupied molecular orbital level of the quinone derivative is sufficiently higher than the highest occupied molecular orbital level of Li_6PS_5Cl. The energy difference is demonstrated to be critical in ensuring chemical compatibility during composite electrode preparation and enable high-efficiency operation of solid-state organic LMBs. Considering these findings, a general principle is proposed for the selection of quinone derivatives to be integrated with Li_6PS_5Cl, and two solid-state organic LMBs, based on 2,5-diamino-1,4-benzoquinone and 2,3,5,6-tetraamino-1,4-benzoquinone, are successfully developed and tested for the first time. Validating critical factors for the design of organic battery electrode materials is expected to pave the way for advancing the development of high-efficiency and long cycle life solid-state organic batteries based on sulfides electrolytes.

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Biography

I am currently doing a Ph.D. at Université Catholique de Louvain, specializing in high-voltage organic cathodes for divalent cation storage. My work focuses on developing sustainable and efficient electrode materials to advance next-generation energy storage systems. By exploring novel organic chemistries, I aim to bridge the gap between organic and inorganic battery materials, contributing to the transition toward more sustainable energy solutions.

Computational and Machine Learning-Assisted Discovery and Experimental Validation of Conjugated Sulfonamide Cathodes for Lithium-Ion Batteries

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Conjugated sulfonamides (CSAs) stand out for their propitious electroactivity and notable stability in ambient conditions, making them suitable candidates for high-potential cathode materials in lithium-ion batteries. This study employs a combination of machine learning, semi-empirical quantum mechanics, and density functional theory methods to evaluate a large library of 11 432 CSA molecules, focusing on material properties crucial for application in batteries. After applying the thresholds for the synthetic complexity score at 2.62 and the redox potential at 3.25 V versus Li/Li+, we identify 50 CSA molecules that are easy to synthesize and suitable for the positive electrode in LIBs. By ranking on the basis of redox potential, 13 CSA molecules having potentials greater than 3.50 V versus Li/Li+ are identified. Through further investigations using molecular dynamics simulations on these reactant molecules and their lithiated products, a molecule is singled out for synthesis and electrochemical evaluation. This molecule, lithium (2,5-dicyano-1,4-phenylene)bis((methylsulfonyl)amide)(Li2-DCN-PDSA), demonstrates a redox potential surpassing those previously reported within the class of CSA molecules. Moreover, the study explores the quantitative structure-property relations of CSAs, yielding insights for the development of CSA-based LIB cathode materials, informed by the comprehensive data assembled. [1]

References:
1. X. Zhou, C. Xu, X. Guo, P. Apostol, A. Vlad, R. A. J. Janssen, S. Er, Advanced Energy Materials 2024, 2401658.

Biography

I am currently doing a Ph.D. at Université Catholique de Louvain, specializing in high-voltage organic cathodes for divalent cation storage. My work focuses on developing sustainable and efficient electrode materials to advance next-generation energy storage systems. By exploring novel organic chemistries, I aim to bridge the gap between organic and inorganic battery materials, contributing to the transition toward more sustainable energy solutions.

π-Conjugated Polymers for Lithium Metal Anodes

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To achieve sustainable society based on the use of renewable energy, the development of rechargeable batteries with high energy density is urgently needed. Lithium metal is an important anode material for increasing battery energy density because of its low electrochemical potential (−3.04 V vs. standard hydrogen electrode) and high theoretical capacity (3860 mAh g^{-1}). However, the insufficient Coulombic efficiency (i.e., Li plating/stripping reaction efficiency) mainly hinders the practical implementation. Solid electrolyte interphase (SEI) composed of reductive decomposition products of electrolytes is considered to induce whisker-like Li deposition, which causes the decomposition of electrolytes and the formation of inactive Li during Li dissolution process, lowering the Coulombic efficiency. To address the above challenge, various advanced electrolytes and artificial SEI have been intensively studied, [1] but further improvements in the Coulombic efficiency is required for the implementation. In this study, we investigated π-conjugated polymers as an interlayer between Li metal and electrolytes to achieve smooth deposition morphology and improve the Coulombic efficiency of Li metal anodes. We selected n-type semiconducting polymers as Li metal interlayers and studied Li plating/stripping reactions and Li deposition morphology along with electrochemical behaviours of the polymers.

Acknowledgements
This work was supported by KAKENHI of the Japan Society for the Promotion of Science (JSPS) (Grant No. JP23K13833).

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Biography

Yuta Maeyoshi is a Senior Researcher at National Institute of Advanced Industrial Science and Technology (AIST), Japan. His research focuses primarily on electrochemistry and physical chemistry of energy strage materials such as polymers, electrolytes, and lithium metal anodes. He received B.S. and M.S. in Applied Chemisty from Osaka University in 2010 and 2012, respectively. He recieved Ph.D. in Applied Chemistry from Tokyo Metropolitan University in 2017. Prior to joining AIST in 2020, he worked as a resercher at Honda R&D Co., Ltd. in 2012-2017 and ABRI Co., Ltd. in 2017-2020.

Cellulose-based cathode material for aqueous zinc-ion battery.

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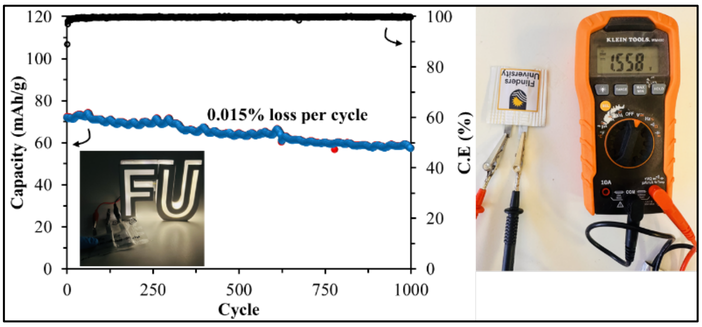
The demand for rechargeable batteries is increasing as electronic technology advances. Lithium-ion batteries (LIBs) are a remarkable innovation in the battery industry. Due to their higher capacity and energy density, they continue to play a significant role as electrochemical energy storage devices. However, some limitations of LIBs, such as shortages of raw materials, environmental hazards, low sustainability, etc., have resulted in significant attention being directed toward more sustainable battery alternatives[1]. Aqueous zinc-ion batteries (AZIBs) have emerged as promising sustainable energy storage systems due to their intrinsic safety, low cost, and environmental friendliness. The cathode material of a zinc-ion battery (ZIB) is crucial, as it determines the overall battery performance, which has driven the investigations on high-performing cathode materials. Consequently, various types of inorganic[2] and polymer-based[3] cathode-active materials have been developed for AZIBs. In addition to performance, bio-safe cathode materials are increasingly significant because hazardous battery waste has emerged as a global issue. This scenario leads to developing more eco-friendly cathode-active materials for AZIBs[4]. In this work, we demonstrated the application of a bio-based polymer as a cathode-active material for AZIB. Cellulose is a naturally occurring abundant biopolymer with an ideal structure, allowing beneficial chemical modifications. In this case, cellulose was chemically modified with 2,2,6,6-tetramethylpiperidin-1-yl)oxyl (TEMPO) groups to obtain a redox-active cellulose-based cathode, which was subsequently tested in polymer-zinc hybrid battery systems with aqueous $Zn(ClO_4)_2$ electrolyte. Our battery recorded an operating voltage of 1.55V and an approximately 60 mAh g^{-1} specific capacity after 1000 cycles, with only 0.015% capacity loss per cycle.



Reference

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Biography

Chanaka Mudugamuwa is a PhD candidate in the College of Science and Engineering at Flinders University, South Australia. He is pursuing his project under the supervision of Assoc. Prof Zhongfan Jia, and his project focuses on degradable polymer batteries. He completed his BSc (in Bioscience) in 2014 in Sri Lanka and his MSc (in Chemistry) in 2021 at Flinders University in South Australia.

Exploring zwitterionic TEMPO for aqueous Zinc-radical redox flow battery

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Aqueous redox flow batteries (ARFBs) have gained significant interest as a scalable and sustainable solution for renewable energy storage, driven by their inherent safety, cost-effectiveness, and environmental compatibility. To overcome the limitations of conventional halogen-based catholytes, organic redox-active materials such as TEMPO derivatives—noted for their non-toxicity, low cost, and structural tunability—have been proposed. Recent advancements employ polymeric catholytes to achieve open-circuit voltages exceeding 1.5 V while lowering costs by integrating size-exclusion membranes in aqueous electrolytes. However, these systems face challenges in capacity density and operational current density, largely attributed to low water solubility and inadequate ionic conductivity of the redox-active species[1].

Addressing these limitations, we were inspired by the unique properties of zwitterionic N-oxide groups—formed by oxidizing tertiary amines,[2][3] where oppositely charged moieties (Me_3N^+–O^-) are directly linked without spacers—to design a novel N-Oxide TEMPO derivative.. This new structure features with exceptional hydrophilicity, achieving unprecedented aqueous solubility (>0.5 g in 0.5 mL of 2 M NaCl, corresponding to >100 Ah/L in theory) and scalable, cost-efficient synthesis. Electrochemical characterization reveals a higher half-wave potential ($E_{1/2}$ = 0.68 V vs. Ag/AgCl) compared to acetylated TEMPO (ACT, 0.59 V), underscoring its enhanced redox activity and suitability for high-performance aqueous Zinc-radical redox flow battery. The N-Oxide TEMPO /Zn battery exhibits a high discharge voltage of 1.5 V and a high current density of up to 22 mAcm^{-2} with a Coulombic efficiency (CE) of over 95 %. Future research efforts will prioritize enhancing the stability of both electrodes to improve cycle life and energy efficiency, thereby advancing overall battery performance.

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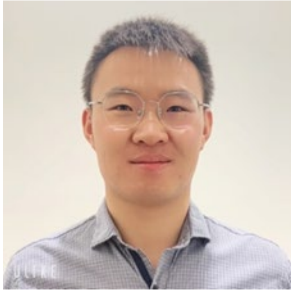

Biography

Dr.Yanlin Shi is currently working at Flinders University as a research associate, focusing on developing high-performance energy storage polymeric materials. He obtained his Ph.D. from the University of Queensland in 2022, specializing in living radical polymerization techniques and precise polymer architecture design. His research interests include polymer synthesis, nanomaterials, and clean energy storage technologies.

Cyclodextrin-based Polymer Gels as Host Materials for High-Performance Zinc-I_2 Batteries

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The increasing demand for efficient and sustainable energy storage solutions has driven research toward advanced battery technologies beyond conventional lithium-ion batteries. Among these, aqueous zinc-ion batteries (ZIBs) have garnered significant attention due to the abundance and affordability of zinc, as well as their promising capacity for high energy density and improved safety [1]. Rechargeable aqueous Zn–I_2 batteries, among various ZIB configurations, stand out for their fast redox chemistry and relatively high specific capacity (211 mAh g ^{1} based on the mass of I2), moderate discharge potential (~1.29 V vs. Zn/Zn^{2+}), and the abundance of oceanic reserves (50-60 µg L ^{1}). However, highly soluble polyiodide intermediates cause a serious shuttle effect, leading to the irreversible loss of active mass. Even worse, the direct reaction between shuttling polyiodide and Zn anodes further aggravates significant Zn corrosion and consumption, resulting in low Coulombic efficiency (CE) and limited durability of Zn-I_2 batteries. Therefore, designing and developing a high-performance host material that can effectively confine polyiodides is an urgent direction that needs development.

In this work, we designed a novel organic cathode material for zinc-iodine batteries by utilizing the host-guest interaction between cyclodextrins (CDs) and triiodide ions (I_3^-). The hydrophobic inner cavity, hydrophilic outer shell, and unique bowl-shaped structure of CDs facilitate easy complexation with linear I_3^- ions. We investigated the binding affinity of α-CD and β-CD toward I_3^- and analysed the electrochemical performance of the resulting iodine-adsorbed materials. Our findings indicated that while α-CD demonstrated a stronger binding affinity to I_3^- compared to β-CD, its electrochemical performance was inferior. This diminished performance likely results from the overly strong host-guest interaction, which reduces the electron transfer kinetics within the electrode, thereby hindering the redox reaction of the adsorbed I_3 ions. Additionally, we compared the electrochemical behaviors of α-CD and β-CD in both small-molecule and polymer gel forms. Among these, the β-CD polymer gel exhibited outstanding electrochemical performance, demonstrating exceptional stability with an ultralow capacity decay of only 0.00093% per cycle over 35,000 cycles at a high current density of 10 A/g.

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Shangxu Jiang began his PhD journey in 2024 at Flinders University under the supervision of A/Prof Zhongfan Jia. His research focuses on polymer energy chemistry, emphasizing the development and design of novel polymer electrode materials for aqueous ion batteries.