The 1st UNIST Electrochemistry Pioneer Symposium 2025

PROGRAM BOOK

November 13th (Thu) ~ 14th (Fri)

UNIST Auditorium

Host | UNIST ECHE

Sponsor | BrainKorea21 FOUR, hydro studio Powered by AI, NRF STEAM, SAMSUNG, SAMSUNG SDI, EES Catalysis

Program Schedule

DAY1 – 2025.11.13.THU

Time	Program	Speaker
09:00 – 09:30	Registration	
09:30 – 09:50	Opening Remarks	UNIST Vice President
	Session 1. Interfacial Breakthroughs in Catalysis (Session Chair: Jungki Ryu)	
09:50 – 10:40	Understanding interfaces for the sustainable production of fuels and chemicals	Thomas Jaramillo (Stanford University)
10:40 – 11:10	Toward practical artificial photosynthesis	Ji-Wook Jang (UNIST)
11:10 – 11:40	Designing interfaces for electrocatalysis	Youngkook Kwon (UNIST)
11:40 – 13:00	Lunch Time	
	Session 2. Interfacial Breakthroughs in Batteries (Session Chair: Seok Ju Kang)	
13:00 – 13:50	Reinventing batteries for a sustainable future	Yi Cui (Stanford University)
13:50 – 14:20	Crystallography-solvation interplay for lithium metal dodecahedra formation	Hyun-Wook Lee (UNIST)
14:20 – 15:00	A quantitative figure of merit for battery SEI films and their use as functional solid-state electrolytes	Yuzhang Li (University of California, Los Angeles)
15:00 – 15:10	Coffee Break	
	Session 3. Understanding Electrochemical Pathways and Interfaces (Session Chair: Seung-Jae Shin)	
15:10 – 15:50	Reactive carbon capture and conversion: pathways to carbon-neutral fuels and chemicals	Marta Hatzell (Georgia Institute of Technology)
15:50 – 16:20	Taming bubbles: engineering wettability across electrolyzer interfaces	Jungki Ryu (UNIST)
16:20 – 16:30	Session Wrap-up	
16:30 – 17:30	UNIST Battery Research Lab Tour (for speakers only)	

DAY2 – 2025.11.14.FRI

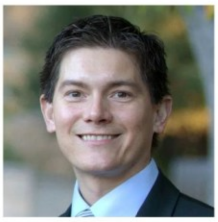
Time	Program	Speaker
09:00 – 09:30	Registration	
	Session 4. AI and Industrial Innovation in Batteries (Session Chair: Hyun-Wook Lee)	
09:30 – 10:10	Maximizing energy density of Ni-based cathode material: single crystalline $LiNi_{0.98}Co_{0.02}O_2$	Jaephil Cho (CEO of SMLAB, Co., Ltd.)
10:10 – 10:50	Energy for AI, AI for energy: How to save the world with electrochemistry	Austin Sendek (CEO of Aionics & Stanford University)
10:50 – 11:30	Computer vision for understanding strain dynamics and chemo-mechanical degradation in batteries	Yijin Liu (University of Texas at Austin)
11:30 – 13:00	Lunch Time	
	Session 5. Breakthroughs in Solid-State Batteries (Session Chair: Won-Jin Kwak)	
13:00 – 13:40	Development of solid-state lithium-sulfur batteries	Ping Liu (University of California, San Diego)
13:40 – 14:20	Seeing is believing – how X-ray probes can help us image solid state batteries	Kelsey Hatzell (Princeton University)
14:20 – 14:30	Coffee Break	
	Session 6. Atomic-Scale Insights through Analysis and Simulation (Session Chair: Hyun-Wook Lee)	
14:30 – 15:10	TEM insights drive breakthroughs: fast-charging, zero-cobalt, zero-strain layered cathodes for lithium-ion batteries	Huolin Xin (University of California, Irvine)
15:10 – 15:40	Computational electrochemistry in atomic scale: a brief history, applications and current stage of its development	Seung-Jae Shin (UNIST)
15:40 – 15:50	Session Wrap-up	

November 13th
09:50–10:40

Understanding interfaces for the sustainable production of fuels and chemicals

As atmospheric concentrations of greenhouse gases continue to rise, there is greater urgency to develop and scale new technologies that are capable of producing fuels and chemicals in a renewable, sustainable manner. This talk will describe R&D efforts along these lines, with a focus on electrochemical and photo-electrochemical processes. Areas of emphasis will include water electrolysis for the production of hydrogen, N_2 reduction for the production of ammonia, and the conversion of CO_2 to carbon-based fuels and chemicals. A major focus is on the electrified interface, where the dynamic microenvironment greatly influences reaction pathways, impacting activity, efficiency, selectivity, and durability. This talk will cover efforts ranging from fundamental studies on model catalyst materials to more applied technological systems.

Thomas Jaramillo



Professor, Dept. of Chemical Engineering, Stanford University
Dept. of Energy Science Engineering, Stanford Doerr School of Sustainability
Photon Science, SLAC National Accelerator Laboratory
Senior Fellow, Precourt Institute for Energy, Stanford University
Director, SUNCAT Center for Interface Science and Catalysis

Thomas Francisco Jaramillo is a Professor of Chemical Engineering and of Energy Science Engineering at Stanford University, along with a faculty appointment in Photon Science at SLAC National Accelerator Laboratory. He serves as Director of the SUNCAT Center for Interface Science and Catalysis, a joint partnership between Stanford and SLAC. Prof. Jaramillo's research efforts are aimed at developing catalyst materials and new processes to improve sustainability in the energy and chemical sectors.
Prof. Jaramillo has authored over 200 publications in the peer-reviewed literature in these areas, and has earned a number of honors and awards for his efforts, including the Paul H. Emmett Award in Fundamental Catalysis (2021) from the North American Catalysis Society, the Resonate Award (2014) from the Resnick Institute, and the Presidential Early Career Award for Scientists & Engineers (PECASE, 2011). Professor Jaramillo is from Carolina, Puerto Rico, earning a BS in chemical engineering at Stanford University and MS and PhD degrees in chemical engineering at the University of California, Santa Barbara. He then pursued post-doctoral research as the Hans Christian Ørsted Postdoctoral Fellow at the Technical University of Denmark, Department of Physics, prior to joining the Stanford faculty.

November 13th
10:40–11:10

Toward practical artificial photosynthesis

Artificial photosynthesis, mimicking natural photosynthesis, stands out as one of the most promising technologies for solar hydrogen production. For this technology to become commercially viable, it must meet three critical criteria: efficiency, stability, and scalability. Notably, the solar-to-hydrogen conversion (STH) efficiency must reach at least 25%. Two primary strategies are key to achieving these goals. The first strategy involves enhancing the efficiency of stable inorganic materials such as TiO_2, Fe_2O_3, and $BiVO_4$. The second strategy focuses on stabilizing high-efficiency materials. In this presentation, I will explore both approaches, with particular emphasis on the latter. I will introduce methods for stabilizing efficient organic or inorganic-organic hybrid-based semiconductors possessing superior charge-transfer characteristics, lower band gap, and tunable energy levels. Moreover, I will discuss several strategies for scaling up photoelectrodes while minimizing losses in STH efficiency. Finally, I will extend these approaches to the production of other solar fuels, such as ammonia (NH_3) and hydrogen peroxide(H_2O_2).

References

1. J. -W. Jang et al. "Photoelectrochemical water splitting with high performance and stable Organic based photoanode." *Nat. Commun.* 2020, 11, 5509
2. J. S. Lee, S. I. Seok and J. -W. Jang et al. "All-perovskite-based unassisted photoelectrochemical water splitting system for efficient, stable, and scalable solar hydrogen production." *Nature Energy* 2024, 9, 272–284
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4. J. -W. Jang, S. -T. Jang and T. F. Jaramillo et al. "Bias-free high-performance solar NH3 production by perovskite-based photocathode and in situ valorization of glycerol." *Nature Catalysis* 2024, 7, 510–521
5. J. -W. Jang, D. -H Seo and T. F. Jaramillo et al. "Unassisted electrochemical H2O2 production coupled to glycerol oxidation." *Nature Synthesis* 2025, 4, 931–939

Ji-Wook Jang

Ji-Wook Jang studied Chemistry at Pohang University of Science and Technology (POSTECH), Republic of Korea, and obtained his PhD degree in Chemical Engineering from the same university in 2012 under the supervision of Prof. Jae Sung Lee. He continued extensive research on different types of photocatalysts, and photocatalytic systems while working at Boston College, USA, and Institute for Solar Fuels, Germany, under the guidance of Prof. Dunwei Wang, and Prof. Roel van de Krol, respectively. He is presently working as a Professor at the School of Energy and Chemical Engineering from 2016. His research interest includes the photochemical production of future energy carriers (H2, H2O2, NH3, etc.) and high valued chemicals.

November 13th
11:10–11:40

Designing interfaces for electrocatalysis

The majority of today's research in electrocatalysis is focused on designing catalyst materials and processes that can surpass the current benchmarks of classical catalysis. However, the development of performance parameters for important electrochemical reactions, such as oxygen evolution reaction and CO_2 reduction reaction, has been slow due to intrinsic limitations such as adsorption energy scaling relation of the intermediate species. Recent theoretical and experimental studies have revealed that designing interfaces plays the key role in enhanced catalytic activity, selectivity, and durability. In this seminar, I'll introduce a couple of applications of interface designed electrocatalysts in CO_2 reduction and water splitting reactions.

Youngkook Kwon

2019–Present: Assistant Professor(2019–2022), Associate Professor(2022–Present), School of Energy and Chemical Engineering, UNIST
2016–2019: Senior Researcher, Korea Research Institute of Chemical Technology (KRICT)
2013–2016: Postdoctoral Researcher, Joint Center for Artificial Photosynthesis (JCAP), Lawrence Berkeley National Lab (LBNL)
2009–2013: Ph.D. in Chemistry, Leiden University

November 13th
13:00–13:50

Reinventing batteries for a sustainable future

Yi Cui

Fortinet Founders Professor
Director, Aqueous Battery Consortium (DoE Energy Hub)
Faculty Director, Sustainability Accelerator
Co-Director, Stanford Ecopreneurship, StorageX Initiative
Dept. of Materials Science and Engineering / Dept. of Energy Science and Engineering / Dept. of Chemistry (Courtesy), Stanford University

Dr. Yi Cui studies fundamentals and applications of nanomaterials and develops tools for their understanding. Research Interests: nanotechnology, batteries, electrocatalysis, wearables, 2D materials, environmental technology (water, air, soil), cryogenic electron microscopy.

2021–Present: Fortinet Founders Professor of Engineering, Stanford University
2005–Present: Assistant Professor(2005–2010), Associate Professor(2010–2016), Professor(2016–Present), Department of Materials Science and Engineering, Stanford University
2011–Present: Photon Science Faculty, SLAC National Accelerator Laboratory
2010–2014: David Filo and Jerry Yang Faculty Scholar
2003–2005: Miller Postdoctoral Fellow, University of California, Berkeley
2002: Ph.D. in Chemistry, Harvard University

November 13th
13:50-14:20

Crystallography-solvation interplay for lithium metal dodecahedra formation

When metallic Li formation is initiated by charge transfer on a Cu current collector, the equilibrium distribution of Li ions in the electrolyte is disrupted, leading to steep concentration gradients that eventually trigger dendritic growth. While many studies have tried to address this issue using concentrated electrolytes, lithiophilic electrodes, or alloying strategies, most approaches have focused only on Li adsorption and overlooked the surface migration of Li atoms immediately after adsorption. In my talk, I will present that Li plating should be viewed as a collective motion of Li adatoms influenced by the crystallographic orientation of the Cu substrate. By comparing centimeter-scale single-crystal Cu(111) and Cu(410) foils, I will show that Cu(111) suppresses dendritic growth due to the near-zero migration barrier of Li adatoms. I will also discuss how electrolyte solvation can override this crystallographic control and direct the formation of faceted lithium metal structures, including dodecahedra. In desolvation-limited electrolytes, strong Li-substrate coupling enforces facet-selective growth, whereas weakly solvating electrolytes preserve partial solvation and shield Li^+ from the substrate, enabling uniform nucleation across orientations. This interplay between crystallography and solvation chemistry points to a new route for rational control of lithium metal morphology. I will highlight how solvation engineering can be used to bypass substrate-driven heterogeneity and to guide the design of stable, high-performance lithium metal anodes for next-generation batteries.

Reference

1. Min-Ho Kim, Dong Yeon Kim, Yunqing Li, Juyoung Kim, Min Hyeok Kim, Jeongwoo Seo, Benjamin V. Cunning, Taewon Kim, Sang-Wook Park, Rodney S. Ruoff*, Dong-Hwa Seo*, Sunghwan Jin*, Hyun-Wook Lee*, *Energy & Environmental Science*, 17 (18) 6521-6532 (2024).
2. Juyoung Kim, Min-Ho Kim*, Huida Lyu, Min Hyeok Kim, Seungwoo Choi, Tae Young Choi, Soon-Jae Jung, Jin Koo Kim, Patrick Joohyun Kim, Rodney S. Ruoff, Yuzhang Li, Sunghwan Jin, Jong-Seong Bae*, Hyun-Wook Lee*, submitted.

Hyun-Wook Lee

Hyun-Wook Lee is currently a Professor in the School of Energy and Chemical Engineering at Ulsan National Institute of Science and Technology (UNIST). He received his B.S. in Advanced Materials Engineering from Sejong University in 2007. He received his Masters of Science and Ph. D. in Materials Science and Engineering in 2009 and 2012 at Korea Advanced Institute of Science and Technology (KAIST). During his Masters and Ph. D. degree studies, his research focused on the synthesis of nanomaterials and Li-ion batteries. In 2012, he moved to a postdoctoral position at Stanford University under the supervision of Prof. Yi Cui. At that time, he carried out research on Prussian Blue open framework structures for Na-ion batteries and in situ/operando transmission electron microscopy (TEM) investigation on battery electrodes under electrochemical reactions. His research group at UNIST pursues innovations in lithium/sodium-ion batteries, operando imaging observation, cryogenic transmission electron microscopy, Prussian Blue-type redox systems, and electrochemically thermal energy harvesting. His published works in this field have been cited more than 25,000 times, and he was selected as a Highly Cited Researcher in 2019, 2020, 2021, 2022, 2023, and 2024 by Clarivate Analytics.

November 13th
14:20–15:00

A quantitative figure of merit for battery SEI films and their use as functional solid-state electrolytes

Artificial intelligence (AI) and electrochemistry are now deeply linked in both challenge and opportunity. As AI systems grow in scale, their electricity consumption is rising sharply—creating new urgency for efficient, renewable energy storage. Meeting that demand will depend on advances in electrochemical technologies capable of stabilizing renewable grids powered by intermittent renewables. At the same time, AI is transforming how we develop those very technologies. Machine-learning models, robotic experimentation, and quantum simulations are accelerating electrolyte and electrode discovery, improving our ability to link molecular structure to performance and commercial feasibility. This talk will examine how energy constrains the growth of AI and how AI can accelerate electrochemical innovation. By connecting these trends, we can build a self-reinforcing cycle: AI drives demand for clean energy; electrochemistry makes that energy possible; and together they form a pathway toward large-scale decarbonization and the development of AI for the social good.

Yuzhang Li

Yuzhang Li is an Associate Professor in Chemical and Biomolecular Engineering at UCLA. He received his bachelor's in Chemical Engineering from UC Berkeley and his Ph.D. in Materials Science and Engineering from Stanford University. The long-term goal of the Li group@UCLA is to invent new tools and materials that address important challenges in sustainability and health. For example, we are leading efforts to leverage the powerful cryogenic electron microscopy (cryo-EM) tool to address grand challenges in sustainability. These efforts have led to significant breakthroughs in our understanding of batteries (*Science* 358, 506, 2017; *Science* 375, 66, 2022) and electrocatalysts (*Nature Energy* 8, 138, 2023), which represent important clean energy technologies necessary for securing energy resilience and security. New insights then inform parallel efforts in materials innovations (*Nature* 620, 86, 2023; *Nature Energy* 10, 502, 2025) that will enable transformative technologies. Yuzhang's research has been highlighted by news media including Forbes, Popular Mechanics, and ABC7 Bay Area, while also being recognized with several awards, including the Packard Fellowship, Dreyfus Teacher-Scholar Award, Forbes 30 Under 30, and young investigator awards from the NSF, DOE, NIH, DOD, ACS, and ECS.

November 13th
15:10–15:50

Reactive carbon capture and conversion: pathways to carbon–neutral fuels and chemicals

Reactive carbon capture and conversion (RCCC) is important because it combines CO_2 capture and its direct conversion into valuable products, eliminating the costly and energy–intensive step of regenerating pure CO_2 from carbonate streams. Using bipolar–membrane electrolyzers, carbon captured as alkaline carbonates can be directly transformed into fuels and chemicals such as ethylene, syngas, and carbon monoxide. This reduces process complexity, lowers separation costs, and minimizes CO_2 losses, ultimately improving both efficiency and economics. RCCC also provides a pathway to scalable, renewable, and potentially carbon–neutral chemical production, helping address climate and resource sustainability challenges. In this talk, I will explore the feasibility of producing syngas, ethylene, and carbon monoxide at industrial scale by electrochemically reducing aqueous alkaline carbonates with BPM electrolyzers. I will highlight engineering considerations for integrating CO_2 capture (from direct air capture or flue gas), opportunities for catalyst design and optimization, and the critical role of upstream and downstream separations.

Marta Hatzell

Marta Hatzell is the Woodruff Professor of Mechanical Engineering and Chemical and Biomolecular Engineering at Georgia Institute of Technology. Hatzell's research group focuses on exploring how to electrify catalytic and separation–based processes to enable sustainable industrial systems. Her group works on materials, characterization, and system analyses for electrolysis, fuel cells, desalination, and solar energy conversion processes. Hatzell currently serves as a Senior Editor of the Journal ACS Energy Letters and is an initiative lead within the Strategic Energy Institute. Hatzell also has served as an expert on issues related to the water–energy nexus for the National Academy of Engineering. She is the recipient of numerous awards including the NSF Early Career, the Gordon and Betty Moore Foundation Inventor award, the ACS sustainable chemistry and engineering lectureship, and the Sloan Fellowship in Chemistry.

November 13th
15:50–16:20

Taming bubbles: engineering wettability across electrolyzer interfaces

Electrochemical systems that involve gaseous reactants or products—such as hydrogen and oxygen evolution, or CO_2 and N_2 reduction—critically rely on how efficiently gases are generated, detached, and transported at solid–liquid interfaces. Beyond catalyst design, the control of interfacial wettability emerges as a decisive factor in governing reaction efficiency, gas crossover, and long-term durability. In this presentation, I will discuss our recent progress on manipulating electrode and cell wettability to achieve efficient and stable water electrolysis. Specifically, we developed a superaerophobic hydrogel coating that universally promotes gas bubble detachment irrespective of electrolyte type or catalyst composition, leading to improved efficiency and stability in both acidic and alkaline electrolyzers. Furthermore, I will present strategies for locally tuning hydrophobicity in porous transport layers (PTLs) to enhance mass transport in AEM cells, and hydrogel-modified diaphragms that effectively suppress H_2/O_2 crossover in alkaline systems. Together, these approaches demonstrate how rational wettability engineering across electrolyzer interfaces can offer a unified framework for advanced gas management in diverse electrochemical environments.

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Jungki Ryu

Jungki Ryu is a Professor at the UNIST School of Energy and Chemical Engineering. He is also an adjunct professor of the UNIST Graduate School of Carbon Neutrality and a director of the Centre for Renewable Carbon at UNIST. Since February 2025, he has served as the Director of the BK21 (Brain Korea 21) Center for AI-Energy Fusion Talent Incubator. He received his BS and PhD degrees in Materials Science and Engineering from Yonsei University in 2006 and the Korea Advanced Institute of Science and Technology (KAIST) in 2011, respectively. Before joining UNIST in 2014, he worked as a postdoctoral research associate at the Massachusetts Institute of Technology. His research interests include water electrolysis, solar fuels, CO_2 conversion and utilization, biomass conversion, and electrochemical waste refinery.

November 14th
09:30–10:10

Maximizing energy density of Ni-based cathode material: single crystalline $LiNi_{0.98}Co_{0.02}O_2$

The ever-increasing demand for energy storage in automotive and other applications requires advanced lithium-ion batteries (LIBs) with higher energy density, longer cycle life and superior safety. As cost reduction is a key driving force, scalable synthesis is required. For LIB cathodes, state-of-the-art Ni-rich layered oxides adopted polycrystalline morphologies, consisting of fine-grained primary particles (around 100 to 200 nm grain size) and assembled secondary particles (around 3–10 μ m diameter). However, these polycrystalline cathodes are prone to intergranular cracking during electrode calendering and battery cycling, which electronically isolates active materials, exposes unprotected fresh surfaces to the liquid electrolyte with more side reactions and degrades the electrochemical performance. To improve stability and reliability, along with maximizing energy density, single-crystalline $LiNi_{0.98}Co_{0.02}O_2$ cathode (micron grain-sized free-standing particles free of grain boundaries) is going to be presented.

Jaephil Cho

2018–Present: Founder & CEO of SMLAB Co., Ltd.

2019–2024: Distinguished Professor of UNIST
2016–2017: Member of Presidential Advisory Council on Science & Technology
2014–2022: Director of Samsung SDI-UNIST Future Batteries Research Center
2009–2024: Professor of School of Energy & Chemical Eng., UNIST
1996–2002: Senior Researcher, Samsung SDI, R & D Center, Suwon, Korea
1995–1996: Post-Doc., Georgia Institute of Technology, Atlanta, GA
Ph.D. in Ceramic Engineering, Iowa State University, Ames, IA, USA

2016–2025: Highly Cited Researcher (material science, chemistry, cross-field)

2014: ICT Innovation Prime Minster Award
2013: 27th Inchon Award (Natural Science Field, Inchon Memorial Foundation)

November 14th
10:10–10:50

Energy for AI, AI for energy: how to save the world with electrochemistry

Artificial intelligence (AI) and electrochemistry are now deeply linked in both challenge and opportunity. As AI systems grow in scale, their electricity consumption is rising sharply—creating new urgency for efficient, renewable energy storage. Meeting that demand will depend on advances in electrochemical technologies capable of stabilizing renewable grids powered by intermittent renewables. At the same time, AI is transforming how we develop those very technologies. Machine-learning models, robotic experimentation, and quantum simulations are accelerating electrolyte and electrode discovery, improving our ability to link molecular structure to performance and commercial feasibility. This talk will examine how energy constrains the growth of AI and how AI can accelerate electrochemical innovation. By connecting these trends, we can build a self-reinforcing cycle: AI drives demand for clean energy; electrochemistry makes that energy possible; and together they form a pathway toward large-scale decarbonization and the development of AI for the social good.

Austin Sendek

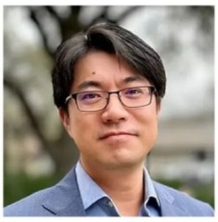
Austin Sendek is Adjunct Professor of Materials Science & Engineering at Stanford University and Co-founder and CEO of Aionics, Inc. His work as an entrepreneur, educator, and researcher focuses broadly on harnessing the power of machine learning and A.I. to accelerate the design and discovery of new materials for decarbonizing the global economy. He founded Aionics in 2020 as the first AI startup to develop, test, and sell new materials and chemicals designed by AI models, commercializing these products with customers including Cellforce Group, the battery division of Porsche. He holds a PhD in Applied Physics from Stanford University and a B.S. in Applied Physics from UC Davis.

November 14th
10:50–11:30

Computer vision for understanding strain dynamics and chemo–mechanical degradation in batteries

Lithium–ion batteries exhibit structural and chemical complexities across multiple length scales. Understanding their function, degradation, and failure requires a holistic perspective that integrates structural, chemical, mechanical, and dynamic insights. These intertwined chemomechanical processes present significant experimental and computational challenges.
In this talk, I will present our efforts to address these challenges by combining advanced operando imaging with computer vision algorithms to visualize the evolving structural hierarchy of real–world battery cells. Our analyses capture damage, deformation, and chemical heterogeneity across different length scales and connect these observations to diverse degradation phenomena.
The results highlight the critical role of electrode mechanical properties, which evolve during cycling and strongly influence both short–term performance and long–term stability.
Our research integrates in–situ experimentation, statistical analysis, numerical modeling, and machine learning, providing a comprehensive framework to probe battery behavior. I hope this presentation will spark new ideas and foster future collaborations in this rapidly advancing field.

Yijin Liu



Dr. Yijin Liu received his B.S. (2004) and Ph.D. (2009) degrees from the Physics Department at the University of Science & Technology of China. He joined Stanford University as a postdoctoral scholar in 2009 and became an Associate Staff Scientist at the SLAC National Accelerator Laboratory in 2012, a Staff Scientist in 2015, and a Lead Scientist in 2020. In August 2023, Dr. Liu joined the Walker Department of Mechanical Engineering at UT Austin as an Associate Professor. In his previous role as a National Lab Scientist, Dr. Liu led the technical developments and scientific applications for the Transmission X–ray Microscopy program at SLAC/Stanford. With over 15 years of experience in this field, Dr. Liu has developed and applied X–ray characterization methods for a broad range of research fields. In more recent years, Dr. Liu's research focused on studying energy storage materials using high–throughput experimental methods as well as machine learning–assisted statistical analysis. Specific areas of focus include battery manufacturing, safety, degradation, and failure analysis.

November 14th
13:00–13:40

Development of solid-state lithium-sulfur batteries

Solid-state lithium-sulfur (Li-S) batteries promise high energy density, long cycle life, and low cost. They naturally address the polysulfide shuttle problem that has plagued that stability of Li-S batteries with liquid electrolytes. However, realizing long cycle life and high utilization for the sulfur cathode is extremely challenging due to low conductivity, low reactivity, and volume change induced microstructural failure. On the other hand, enabling a stable lithium metal anode is a difficult task in its own right.

We will discuss our progress on tackling challenges of both electrodes. On the cathode side, we have focused on improving sulfur-based and lithium sulfide-based cathodes. To improve the conductivity of sulfur, we have shown that introducing halide dopants can form new compounds with appreciable electronic conductivities. Sulfur iodide, for example, also appear to stabilize the polysulfide intermediates, which are otherwise known to be unstable in the solid state. Degradation induced by the large volume change can be reversed by remelting the cathode. Recently, we have also revisited the approach of activated Li_2S as the cathode. One potential advantage is the reduced volume change. To improve the reactivity, we have introduced several dopants (both metal and non-metal). Selected dopants have shown the ability to improve electronic and ionic conductivities and to enhance reactivity through the stabilization of polysulfide intermediates in the solid state.

The challenges of the lithium anode are related to its reactivity with the sulfide electrolytes. Carbon-based interlayers which often contain alloy-forming metals have been shown to be effective. We have focused on understanding the selection rules for the interlayer material and how carbons with high surface area and lithiophobility can serve as an effective mixed ion/electron conductor. We will also discuss recent progress in interface control to reduce the need for interlayers which can simplify the manufacturing process. Collectively, these advancements promise to push the energy density and cycle life of solid state Li-S batteries towards practical utility.

Ping Liu

Dr. Ping Liu is William Coles Chair Professor of Nanoengineering and Director of the Sustainable Power and Energy Center (SPEC) at UC San Diego. Prof. Liu's research focuses on electrochemical materials science including its applications in energy conversion and storage as well as nanomaterials synthesis. His work on rechargeable lithium batteries include design of both solid and liquid electrolytes, sulfur cathodes, and safety. Prior to joining the Jacobs School faculty in 2016, Prof. Liu was a Program Director at the Advanced Research Projects Agency – Energy (ARPA-E), where he initiated and managed research programs totaling $100M in energy storage for electric vehicles and thermal management technologies to improve building energy efficiency. He was the manager of the Energy Technology Department at HRL Laboratories and was a research staff member with the National Renewable Energy Laboratory (NREL). Prof. Liu has published over 180 peer-reviewed papers and has been issued 60 US patents. He is a co-founder of Tyfast Energy and a founding advisor to Sonocharge. He received an R&D 100 Award for a solid state battery technology developed at NREL.

November 14th
13:40-14:20

Seeing is believing – how X-ray probes can help us image solid state batteries

Transportation accounts for 23% of energy-related carbon dioxide emissions and electrification is a pathway toward ameliorating these growing challenges. All solid state batteries could potentially address the safety and driving range requirements necessary for widespread adoption of electric vehicles. However, the power densities of all-solid state batteries are limited because of ineffective ion transport at solid|solid interfaces. New insight into the governing physics that occur at intrinsic and extrinsic interfaces are critical for developing engineering strategies for the next generation of energy dense batteries. However, buried solid|solid interfaces are notoriously difficult to observe with traditional bench-top and lab-scale experiments. In this talk I discuss opportunities for tracking phenomena and mechanisms in all solid state batteries in-situ using advanced synchrotron techniques. Synchrotron techniques that combine reciprocal and real space techniques are capable of tracking multi-scale structural phenomena from the nano- to meso-scale. This talk will discuss the role microstructure plays on transport and interfacial properties that govern adhesion. Quantification of salient descriptors of structure in solid state batteries is critical for understanding the mechanochemical nature of all solid state batteries.

Kelsey Hatzell

Dr. Hatzell is an associate professor at Princeton University in the Andlinger Center for Energy and Environment and the Department of Mechanical and Aerospace Engineering. Hatzell's group primarily works on energy storage and is particularly interested in using non-equilibrium X-ray techniques to probe materials for energy and separation applications.
Dr. Hatzell earned her Ph.D. in Material Science and Engineering at Drexel University, her M.S. in Mechanical Engineering from Pennsylvania State University, and her B.S./B.A. in Engineering/Economics from Swarthmore College. Hatzell's research group works on understanding phenomena at the solid-liquid, solid-gas, and solid-solid interfaces broadly work in energy storage and conversion.
Hatzell was an ITRI-Rosenfeld Postdoctoral Fellow at Berkeley Lab and an NSF Graduate Research Fellow. She received the Arthur Nowick Award from Materials Research and the Silver Graduate Student Award in the Materials Research Society. Hatzell is the recipient of several awards including the ORAU Powe Junior Faculty Award (2017), NSF CAREER Award (2019), ECS Toyota Young Investigator Award (2019), finalist for the BASF/Volkswagen Science in Electrochemistry Award (2019), the Nelson "Buck" Robinson award from MRS (2019), Sloan Fellowship in Chemistry (2020), and POLiS Award of Excellence for Female Researchers (2021), NASA Early Career Award (2022), ONR Young Investigator Award (2023), Camille-Dreyfus Teacher-Scholar Award (2024), and the Presidential Early Career Award for Scientists and Engineers (2025).

November 14th
14:30-15:10

TEM insights drive breakthroughs: fast-charging, zero-cobalt, zero-strain layered cathodes for lithium-ion batteries

All EV makers are eager to eliminate cobalt from their battery packs not only for cost reduction but also because cobalt is singly sourced from the Democratic Republic of Congo where child labor is used to mine these minerals—it is of economical as well as humanitarian importance to develop high-energy, safe cathode chemistries that have zero cobalt content. In this talk, I will talk about how in-situ transmission electron microscopy studies inspire us to develop a universal strategy to eliminate cobalt entirely and reduce the Ni content in traditional stoichiometric layered cathodes (e.g. NMC, NCA, etc.) while achieving long cycle life(>3000cycles), effective zero volume change ($\Delta V/V$ < 0.3%), high specific energy (>800 wh/kg) and high charge rate (>170 mAh/g at 5C). We will also demonstrate that this zero-strain cathode has unique advantages in solid-state batteries.

Huolin Xin

Huolin Xin is currently a full professor in the Department of Physics and Astronomy at UCI. He received his Ph.D. from the Physics Department of Cornell University in 2011. He worked at Brookhaven National Laboratory as a scientific staff member and a principal investigator from 2013 to 2018. He is an expert on studying structure-property relationships for a range of battery materials and liquid/polymer/solid electrolytes. Xin holds a strong track record in leading multidisciplinary studies in the battery field. He is the lead PI in charge of managing a $2.5-million DOE Vehicle Technology Office project on low-to-no-cobalt lithium-ion batteries. He was named the Climate Action 30 by Insider and Highly Cited Researcher by Clarivate. He received the MRS Outstanding Early-Career Investigator Award, the DOE Early Career Award, the MSA Burton Medal Award, the UCI Distinguished Early-Career Faculty for Research, the Beall Innovation Award in Physical Science. Xin has published more than 300 peer-reviewed publications and has co-authored more than 43 publications in Science and Nature sister journals (corresponding author on 18).

November 14th
15:10–15:40

Computational electrochemistry in atomic scale: A brief history, applications and current stage of its development

Theoretical frameworks have given a general guideline to electrochemists for understanding the multiscale nature of electrochemical reactions. The Nernst equation, Butler–Volmer equation, and Nernst–Planck equation are the major frameworks to understand thermodynamics, kinetics, and transport phenomena. However, these key theories are not efficient enough to figure out every detail with the development of rapid nanotechnologies, the enormously expanded material space, different cell configurations, and versatile reactions.
Computational electrochemistry investigates electrochemical phenomena, including the interface, charge transfer, and mass transport. It can effectively address many intriguing questions with the help of different levels of theories and computational approaches.
Atomic–scale computational chemistry has gained attention since Professor Nørskov successfully explained the 'origin of overpotential' at different oxide materials for oxygen evolution reactions. After this theory, a.k.a., d–band theory, the computational electrochemistry in atomic resolution has been widely developed by many theoretical electrochemistry groups worldwide.
In this seminar, I will discuss the brief history of atomic–scale computational electrochemistry and its applications to electrocatalysis. A short summary of the current state of its development including utilisation of machine learning potential will also be covered. Finally, its potential application to understand wide range of phenomena in (photo)electrochemical stystem, next generation batteries, and catalysis will be discussed.

Seung–Jae Shin

2024–Present: Assistant Professor, School of Energy and Chemical Engineering, UNIST
2023–2024: Research Fellow, Imperial College London
2022–2023: Postdoctoral Researcher: Yonsei University
2022: Ph.D. in Chemistry, KAIST

2024: CECAM Best Poster Award
2023: S–Oil Best Paper Award in Chemistry
2020: KIChE 2020 fall, Hoimyung Graduate School Research Award, Association of Physics– Electrochemistry Section Winter Symposium Best Poster Award

UNIST Campus Map

Symposium	201 Main Administration Building (15.Bldg.)
Lunch for Participants	206 Cafeteria (20.Bldg.)

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