NIMS AWARD
National Institute for Materials Science

NIMS AWARD SYMPOSIUM 2026

Engineering the Future of

SOLID STATE BATTERIES

November 10 (Tue), 2026

TSUKUBA International Congress Center Convention Hall 300

Abstracts

National Institute for Materials Science

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*GREEN: Research Center for Energy and Environmental Materials

Greetings from the President



It is my great pleasure to welcome you to the NIMS Award Symposium 2026.

Established in 2007, the NIMS Award recognizes outstanding achievements in materials science and honors researchers whose work has opened new frontiers and contributed significantly to the advancement of the field. Over the past two decades, the Award has celebrated distinguished scientists whose research has had a lasting impact on materials science and its applications.

This year, NIMS is honored to present the NIMS Award to Professor Ryoji Kanno and Professor Masahiro Tatsumisago for their pioneering research on solid electrolytes enabling all-solid-state batteries. Their pioneering research on solid electrolytes has established the scientific foundations for the development of all-solid-state batteries and has played a major role in advancing the field.

Reflecting the significance of their achievements, this year's symposium is held under the theme "Engineering the Future of Solid-State Batteries." Building on the accomplishments of this year's awardees, the symposium brings together leading researchers from around the world to discuss the materials science underlying all-solid-state batteries, including solid electrolytes, ion transport, electrode-electrolyte interfaces, and battery performance. Through these discussions, we hope to deepen our understanding of the fundamental science and explore new directions toward the realization of practical all-solid-state batteries.

The NIMS Award Symposium has always been more than an award ceremony. It has served as a forum where outstanding scientific achievements are shared, discussed, and connected to future directions in materials research. I hope that today's symposium will continue this tradition by stimulating new ideas, encouraging scientific exchange, and creating opportunities for new collaborations.

Beginning next year, the legacy of the NIMS Award will be carried forward and further developed through the NIMS Distinguished Lecture Series, with a stronger emphasis on sustained intellectual exchange, closer connections between distinguished researchers and NIMS, and new opportunities for collaboration. Through this new initiative, we aim to build an expanding network of leading scientists and continue to advance materials science through scientific excellence, exchange, and collaboration.

I warmly congratulate Professor Kanno and Professor Tatsumisago on receiving the NIMS Award 2026, and I hope that this symposium will be both a memorable celebration of their achievements and an inspiring forum for future advances in materials science.

Thank you for joining us on this special occasion.

Kazuhiro Hono
President, NIMS

Program

9:30 - 10:00 | Registration

10:00 - 10:15 | Opening Remarks and Overview of NIMS by President Kazuhiro Hono

10:15 - 10:20 | Greetings from Guest of Honor

NIMS Award Session

10:20 - 10:35 | **NIMS Award Ceremony** [Chair: Dr. Takashi Taniguchi]

[Chair: Dr. Takuya Masuda]

10:35 - 11:15



NIMS Award Winning-lecture NA-01

Ryoji Kanno

Institute Professor, Institute of Science Tokyo

"Between Electrochemistry and Materials Science
–The Road from Ionic Conductor to Solid-State Batteries–"

11:15 - 11:55



NIMS Award Winning-lecture NA-02

Masahiro Tatsumisago

Executive Advisor, Osaka Metropolitan University

"Development of Glass-Based Inorganic Solid Electrolytes for All-Solid-State Batteries"

11:55 - 12:00 | Group photo

12:00 - 14:00 | **Lunch & Poster Session** Poster Core Time 13:00-14:00

Session 1

[Chair: Dr. Denis Yu]

14:00 - 14:30



Invited Talk IT-01 Linda Faye Nazar

Professor, University of Waterloo, Canada

"The Role of Anion Dynamics in Solid State Electrolytes for Solid State Batteries"

14:30 - 15:00



Invited Talk IT-02 Yasutoshi Iriyama

Professor, Nagoya University

"Fundamental Research and Development of All-Solid-State Batteries in JST-GteX Project"

15:00 - 15:30



Invited Talk IT-03 Jürgen Janek

Professor, Justus Liebig University Giessen, Germany

"The Rise of Sulfide-Based Solid-State Batteries and Remaining Challenges"

15:30 - 16:00



NIMS Talk NT-01 Naoaki Kuwata

Group Leader, Solid State Battery Ionics Group, GREEN*

"Analysis of Lithium-Ion Transport in Solid-State Batteries by NMR and SIMS"

16:00 - 16:20 | Coffee Break

Session 2

[Chair: Dr. Toshihiko Mandai]

16:20 - 16:50



Invited Talk IT-04 Stefan Adams

Associate Professor, National University of Singapore

"Finding Strength in Softness – On the Path to Durable Solid-State Batteries"

16:50 - 17:20



Invited Talk IT-05 Yosuke Fukuyama

Division Manager, Consortium for Lithium Ion Battery Technology and Evaluation Research Center, LIBTEC

"Development of Next-Generation All-Solid-State Battery Assessment and Enabling Technology in SOLiD-Next Project"

17:20 - 17:50



NIMS Award Special Lecture NT-02 Kazunori Takada

Distinguished Research Fellow / Group Leader, Solid-State Battery Group, GREEN*

"Connecting Material Properties with Battery Performance"

17:50 - 17:55 | Closing Remarks by Takuya Masuda, Director of GREEN*

18:15 - 20:00 | NIMS Award Reception 1F Multi-purpose Hall

* GREEN : Research Center for Energy and Environmental Materials

Poster Presentation List

1. Battery and Cell Materials Field			
No.	**Name**	**Affiliation/University**	**Presentation Title**
P1-01	Arghya Dutta	NIMS	Revisiting Ethylene Carbonate: A Self-Limiting Cathode Interphase for High-Voltage Li|Li_2RuO_3 Cells
P1-02	Arpita Das	NIMS	Mitigation of Chemical Crossover in High-Voltage LRO Lithium Metal Cells Using Li-ion Conducting Barrier
P1-03	Hong Rim Shin	NIMS	Deciphering Intertwined Kinetic and Transport Limitations of Practical-Level Lithium Iron Phosphate Cathodes
P1-04	Manai Ono	NIMS	Physicochemical Characterization of Amide-Based Electrolytes for Lithium-Oxygen Batteries
P1-05	Shu-Chi Wu	NIMS	Closed-Loop Bayesian Optimization of Electrolyte Additives for Sodium-Ion Batteries
P1-06	Yanan Gao	NIMS	Lithium-Anode Accessibility Alters the Downstream Evolution of TEGDME-Derived Products in Li-O_2 Batteries
P1-07	Monira Parvin	NIMS	Accelerating $LiMn_2O_4$ Kinetics via Equimolar Multi-Element Doping
P1-08	Ridwan Pratama Putra	NIMS	Uncovering the Electrochemical Lithiation Characteristics of Silicon Anodes in All-solid-state Lithium-ion Batteries: A Study Using Single-crystal Silicon Model Electrodes
P1-09	Tsukasa Iwama	NIMS	Operando X-ray Photoelectron Spectroscopy Study on a SiO_x Thin-Film Electrode on a $Li_{6.6}La_3Zr_{1.6}Ta_{0.4}O_{12}$ Solid Electrolyte
P1-10	Kei Kubota	NIMS	Determining Battery Material Performance through Real-Time Synthesis Tracking
P1-11	Kimihiko Ito	NIMS	Investigation of the Li chemical state inside batteries using XRS: Attempts to obtain Li K XANES within battery cells and remaining issues.
P1-12	Shuhei Kobayashi	NIMS	Co-sintering reaction analysis of cathode materials ($LiFePO_4$ - $LiNiPO_4$) and oxide-based solid electrolyte $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$
P1-13	Syuaibatul Islamiyah	NIMS	Correlating the Surface Chemistry of Hard Carbon with Its Stability toward Humid Air Exposure
P1-14	Agnesia Permatasari	NIMS	Single-Particle Modeling of Electrolyte-Dependent Charge-Transfer and Lithium Transport in NCM Cathodes
P1-15	Masaki Takeguchi	NIMS	Development of an Environmental Cell TEM Holder with Photo-Illumination Function
P1-16	Swati Singh	NIMS	Bridging the Missing Process-Structure Link in Pt-CeO_2 Nanostructures Using Transfer-Learned STEM Representations
P1-17	Toshihiko Mandai	NIMS	Evaluation protocol of Mg plating activity in ethereal and non-ethereal electrolyte solutions
P1-18	Reona Iimura	NIMS	Design of Oxide-Based Positive Electrode Materials with One-Dimensional Ion Diffusion Pathways
P1-19	Ayana Kobayashi	NIMS	Structure-Electrochemical Property Relationship of Weakly Coordinated Anion-Based Electrolytes
P1-20	Mayanmi Zimik	NIMS	Dual-Metal Pre-Intercalation for Highly Reversible $VOPO_4$ Cathodes with Suppressed Vanadium Dissolution in Aqueous Zinc-Ion Batteries
P1-21	Abduhabir Mirza	NIMS	Sequential Two-Step Solution Processing of Wide-Bandgap Perovskite Solar Cells for Tandem Applications
P1-22	Md Ataur Rahman	NIMS	Interface-Guided Buried Interface Enables Efficient and Stable Pb-Sn Mixed Perovskite Solar Cells
P1-23	Denis Yu	NIMS	In-operando Techniques to Quantify Gas Generation and Deposition/Stripping Processes on Zinc Electrodes
P1-24	Cheol Bak	NIMS	Influence of Image Preprocessing and Segmentation Settings on the 3D Reconstruction of a Battery Electrode from FIB-SEM Images
P1-25	Shao-Chu Huang	NIMS	Investigation of carbon and Sn-based alloy composites with ether-based electrolytes for sodium-ion batteries

1. Battery and Cell Materials Field			
No.	**Name**	**Affiliation/University**	**Presentation Title**
P1-26	Zhenfei Cai	NIMS	Inducing reconstruction of Li-rich layered oxides to improve electrochemical performance of $Li_{1.2}Ni_{0.2}Mn_{0.6}O_2$
P1-27	Akihiro Nomura	NIMS	Highly-porous carbon nanotube sheet for High-Power Lithium-Air Battery
P1-28	Kei Nishikawa	NIMS	Ionic Mass Transfer during Electrodeposition and Dissolution of Li Metal
P1-29	Marcela Calpa	NIMS	High-Capacity Mn-Based Disordered Rocksalt Cathodes for All-Solid-State Lithium Batteries
P1-30	Jorge Gonzalez Morales	NIMS	Understanding Interfacial, and Electrolyte Degradation of $LiNbO_3$-Coated Li_2RuO
P1-31	Sihao Xing	NIMS	Operando Time-of-Flight Secondary Ion Mass Spectrometry Visualization of Reversible and Irreversible Reactions in Oxide-Based Solid-State Batteries
P1-32	Randy Jalem	NIMS	Ion Dynamics and Correlation Study in Solid Electrolytes for All-Solid-State Batteries by Molecular Dynamics Simulations
P1-33	Shogo Miyoshi	NIMS	Sinterability Improvement of NASICON-type Electrolyte for Solid-state Battery
P1-34	Halimah Harfah	NIMS	Anion-Sublattice Engineering of $LiNbOCl_4$ Oxyhalide Solid Electrolytes for Enhanced Li-Ion Transport
P1-35	Yifan Xia	NIMS	Synthesis of Low Melting Point $Li_{2.43}Al_{0.21}BO_3$ Solid Electrolytes with Enhanced Lithium Ionic Conductivity
P1-36	Sou Taminato	Mie University	Interfacial Stability between $LiNbO_3/Nb_2O_5$-Coated 4 V-Class Cathode $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ and PEO-Based Polymer Electrolyte
P1-37	Hikari Sano	Chiba Institute of Technology	Effects of Co-substitution in the Lithium-Ion Conductor $LiTa_2PO_8$
P1-38	Ajay Mohan	IIT Gandhinagar	Design of Transition Metal Doped Lanthanum based Perovskites as Cathode Material for Rechargeable Zinc Air Battery Application
P1-39	Kuniharu Nomoto	Institute of Science Tokyo	Performance of Ultrathin Lithium Metal Anodes with Li-Mg Alloying in All-Solid-State Batteries
P1-40	Naoki Matsui	Institute of Science Tokyo	Material Exploration of Anion Conductors for High-Energy Storage Devices
P1-41	Julia Hudachek	Institute of Science Tokyo	Quantitative Visualization of Reaction Inhomogeneity in Graphite Composite Electrodes for All-Solid-State Batteries
P1-42	Saito Itakura	Institute of Science Tokyo	Structure-Based Design of Fluoride-Ion Conductors
P1-43	Yusuke Suzuki	Institute of Science Tokyo	Degradation Behavior of Uncoated Single-Crystal-Like and Polycrystalline NCM523 in All-Solid-State Batteries
P1-44	Yuko Fukada	Institute of Science Tokyo, Tosoh Corporation	Application of Electrolytic Manganese Dioxide as a Cathode Material for Lithium-Ion Batteries
P1-45	Kohei Aso	Japan Advanced Institute of Science and Technology	Low-Dose Nanostructural Mapping of Battery Cathodes by 4D-STEM
P1-46	Anna Sciazko	The University of Tokyo	Ultra-High-Resolution 3D Microstructure Characterization of All-Solid-State Sodium Batteries
P1-47	Fumihiko Ichihara	National Institute of Advanced Industrial Science & Technology	Co-sintering Reaction Analysis of $LiCoO_2$ Cathodes and NASICON-Type LATP Solid Electrolytes Studied by Experimental and Computational Methods
P1-48	Kotaro Yoshida	Tohoku University	Resolving Hetero-Electrolyte Ion-Transport Resistance: A Four-Electrode Approach
P1-49	Canceled		
P1-50	Kazuhiro Hikima	Tokyo Metropolitan University	Surface Chemistry of Sulfide Solid Electrolytes Synthesized by Liquid-Phase Methods and Its Impact on All-Solid-State Battery Performance
P1-51	Youngmin Lee	Solivis Inc.	Chemically Active LiH_2PO_4 Interphase Precursor Enables Self-Limited Interface Stabilization in Sulfide-Based All-Solid-State Batteries
P1-52	Xueyan Hou	Tohoku University	From Oxygen in the Bulk to Lithium at the Interface: Chemical Potential and Stability in Battery Materials

2. Hydrogen Technology Materials Field			
No.	**Name**	**Affiliation/University**	**Presentation Title**
P2-01	Akihiro Kikuchi	NIMS	The ultrafine Nb_3Sn superconducting wires and flexible cables
P2-02	Hisao Kiuchi	NIMS	Toward Operando Observation of Active Site Dynamics in Oxygen Evolution Catalysts by Lab-Scale Near-Ambient Pressure XPS
P2-03	Shruti Jain	NIMS	Systematic Nanoscale Observation of Rhodium Particles on Strontium Titanate ($Rh/SrTiO_3$) Catalyst via Advanced Scanning Transmission Electron Microscopy
P2-04	Soshi Iimura	NIMS	Catalytic Properties of Hydrogen Ions in Materials
P2-05	Taku Suzuki	NIMS	Surface hydrogen analyzed by low-energy ion beams
P2-06	Shusaku Shoji	NIMS	Development of Ortho-Para Hydrogen Conversion Catalysts for Hydrogen Storage
P2-07	Tetsuya Kako	NIMS	Enhancement of Hydrogen Evolution Activity for Carbon Nitride Photocatalyst through Defect Engineering
P2-08	Boborahimov Azamat Boborahim Ugli	NIMS	Syngas-derived hydrophilic nanocarbons for water purification
P2-09	Sarah Nadiah Nordin	NIMS	Direct Cobalt-Tantalum Carbide Heterointerfaces via Selective Carburization for Oxygen Evolution Catalysis
P2-10	Koji Kamiya	NIMS	Magnetic Refrigeration for Hydrogen Liquefaction
P2-11	Kyohei Natsume	NIMS	Active Magnetic Regenerative Refrigerator with Rotating Permanent Magnet.
P2-12	Ya Xu	NIMS	Development of an Effective CuO Hydrogen Permeation Barrier Layer on $ErCo_2$ Magnetic Refrigeration Materials
P2-13	Hideshi Ooka	NIMS	Microkinetic Approaches Towards a Predictive Understanding of Electrocatalysis
P2-14	Koichi Yatsuzuka	NIMS	Application of EIS to determine reaction rate constants of the electrocatalytic hydrogen evolution/oxidation reaction
P2-15	Sahaya Vijay Jeyaraj	NIMS	Microkinetic Faradaic Impedance of Hydrogen Evolution and Oxidation Reactions via the Heyrovsky-Volmer-Tafel Mechanism
P2-16	Gen Nishijima	NIMS	Development of Superconducting Joint Evaluation System
P2-17	Yasuaki Takeda	NIMS	Superconducting Joint between High-temperature Superconducting Wires
P2-18	Miu Aizawa	Chiba Institute of Technology	Crystal structure, thermal stability, and proton conductivity of $RbMg_{1-x}H_{2x}(PO_3)_3 \cdot yH_2O$ with a P_3O_9-ring-based tunnel structure
P2-19	Ryoga Kawai	Chiba Institute of Technology	Synthesis, Crystal Structure and Proton Conductivity of a Mixed Cation Phosphate, $NaCa_{1-x}Li_xH_x(PO_3)_3 \cdot yH_2O$
P2-20	Tetsuro Morooka	Fukushima University	Effect of cerium modification of the oxygen reduction reaction activity of platinum electrode after sulfur-poisoning
P2-21	Jinhui Shi	Kyoto University	Proton Transport under Reduced Humidity in Fluorinated Bisphosphonate-Bridged Zirconium(IV) Phosphonates
P2-22	Shibghatullah Muhammady	RIKEN	Thermodynamic Stability and Ion-Exchange Kinetics of Barium Titanium Oxyhydride from First Principles
P2-23	Masaaki Yoshida	Yamaguchi University	Operando X-ray Absorption Spectroscopy of Carbonate Nickel Electrocatalysts for Water Electrolysis: Roles of Carbonate Anions and Alkali Metal Cations
P2-24	Ryosuke Ono	Yamaguchi University	Development and Operando XAFS Analysis of Ni/FeO_x Water Splitting Catalysts Prepared by Electrodeposition of NiO_x on FeO_x Powders

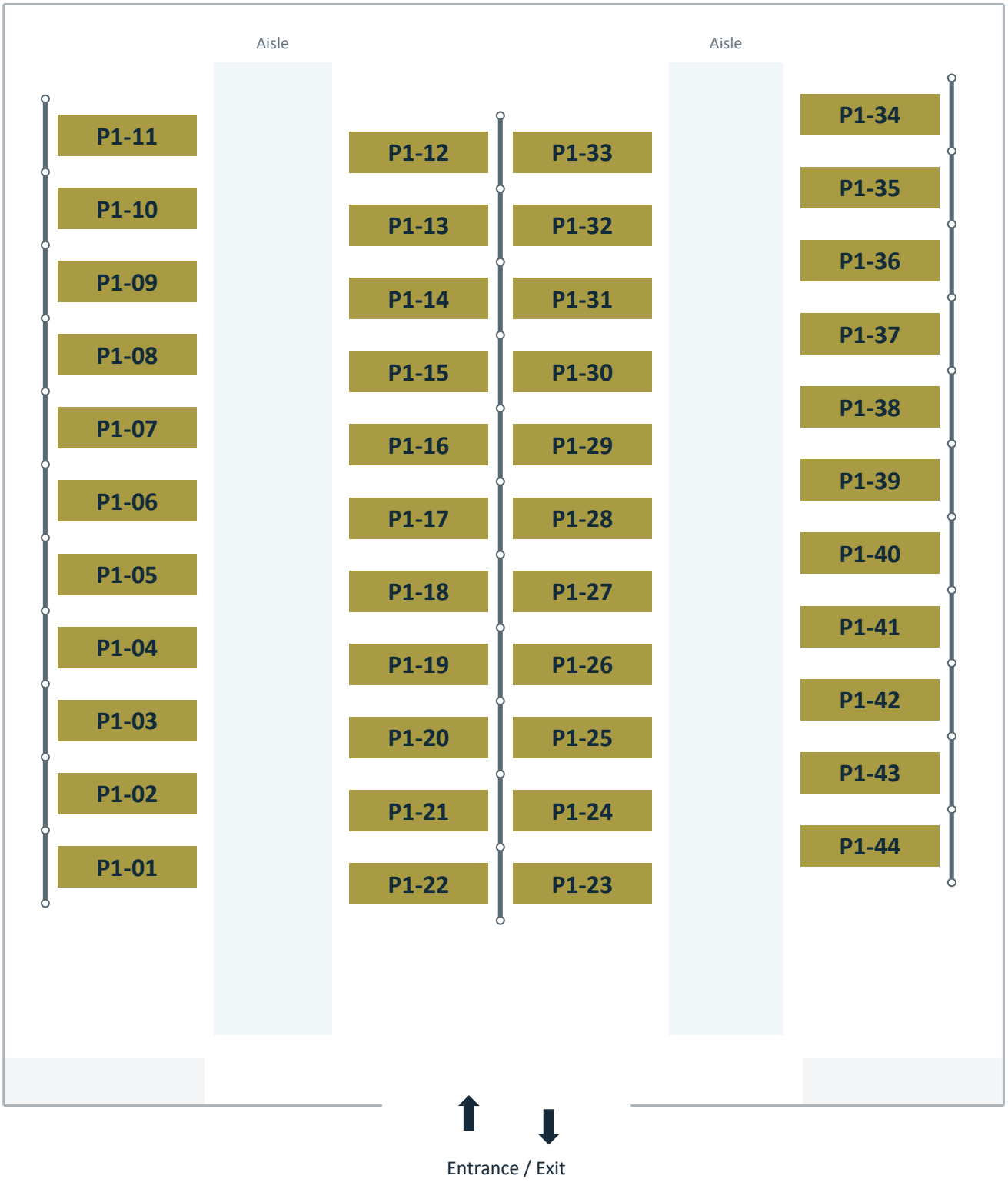
3. Others			
No.	**Name**	**Affiliation/University**	**Presentation Title**
P3-01	Nobuya Banno	NIMS	Multi-dimensional microstructure control in Nb_3Sn superconductors toward fusion energy
P3-02	Sanghamitra Das	NIMS	N-doped Niobium MXenes via Hydrothermal and Annealing Routes for Enhanced Electrochemical Performance
P3-03	Kunie Ishioka	NIMS	Robust coherent phonon mode at GaP/Si(001) heterointerface
P3-04	Ayako Hashimoto	NIMS	Quantitative analysis of in-situ TEM images of defective graphene via persistent-homology-based structural analysis
P3-05	Isao Sakaguchi	NIMS	Preparation of $(Li,La)TiO_3$ ceramics with high grain boundary Li-ion conductivity and visualization of Li-ion transport pathways by negative oxygen ion irradiation
P3-06	Takashi Hirayama	NIMS	Particle Shape Governs Conduction Loss in Cryogenic Magnetic Refrigerators
P3-07	Dhruba B. Khadka	NIMS	Pb-free Perovskite Solar Cells
P3-08	Yasuhiro Shirai, Masatoshi Yanagida, Habiru Miruza	NIMS	Durability test and degradation mechanism of metal halide perovskite solar cells
P3-09	Md. Zobaidul Hossen	NIMS	Conjugated Self-Assembled Monolayer Functionalized with Methoxy Group as Hole-Selective Material for p-i-n Perovskite Solar Cells
P3-10	Hiroki Fujii	NIMS	Development of Lightweight MgB_2 Conductor
P3-11	Aadya Tripathi	India International School in Japan	Crochet Mesh Reinforcement for Seismic Ceiling Safety: A Preliminary Mechanical Investigation of Gypsum Panel Failure Behavior
P3-12	Shanmugapriya Indrani Govindarasu	Indian Institute of Science	Heterometallic ludwigite $M_{2.5}T_{0.5}(O_2BO_3)$ and $(M_2T)(O_2BO_3)$ (M = Co, Ni, Cu; T = Ti, Sn, Fe) compounds as electrocatalysts

Poster Map

44 posters

ROOM 303

- P1 Battery and Cell Materials Field
- P2 Hydrogen Technology Materials Field
- P3 Others



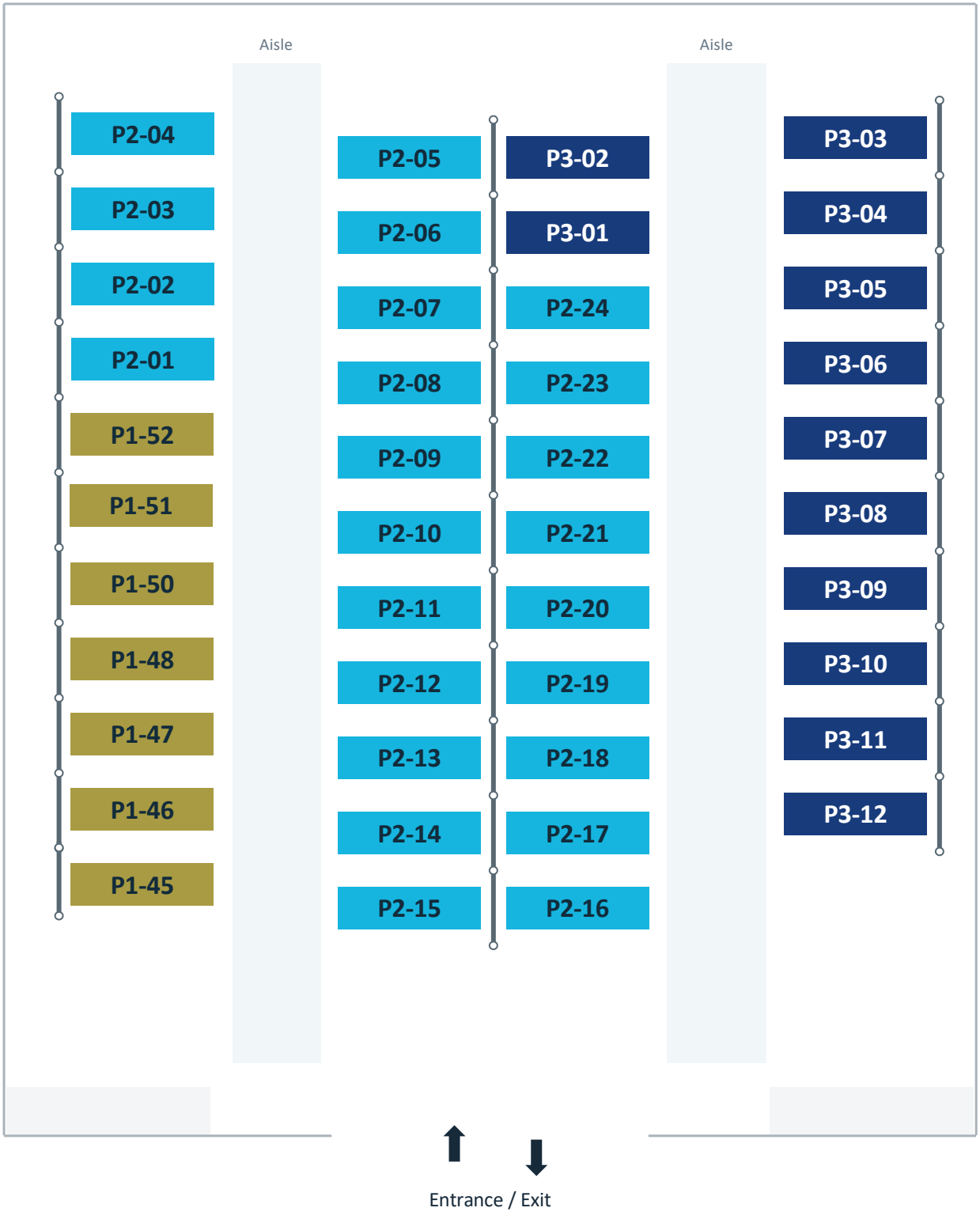
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Poster Map

43 posters

ROOM 304

- P1 Battery and Cell Materials Field
- P2 Hydrogen Technology Materials Field
- P3 Others



Poster Number: P1-45–52, P2-01–24, P3-01–12

NIMS AWARD 2026

NIMS Award 2026

NIMS (National Institute for Materials Science) presents the NIMS Award 2026 to Prof. Ryoji Kanno from the Institute of Science Tokyo and Prof. Masahiro Tatsumisago from Osaka Metropolitan University. This year's award is presented under the theme "Energy Storage Materials."

Research Achievement

Solid Electrolytes Enabling All-Solid-State Batteries

The two recipients were recognized for their pioneering research on solid electrolytes enabling all-solid-state batteries.
This year's selection focused on the field of environmental and energy materials, with the aim of honoring exceptional achievements pertaining to "Engineering the Future of SOLID STATE BATTERIES". Prof. Kanno paved the way for crystalline solid electrolytes exhibiting high ionic conductivity, whereas Prof. Tatsumisago pioneered the development of amorphous solid electrolytes. These achievements have led to industrial applications, including automotive batteries and stationary energy storage systems, as a key technology for realizing safe and high-energy-density next-generation batteries, and have become an important technological foundation for achieving a carbon-neutral society.

Prof. Ryoji Kanno
Institute Professor, Institute of Science Tokyo

Prof. Masahiro Tatsumisago
Executive Advisor, Osaka Metropolitan University

NIMS Award Medal







NIMS Award gold medal is crafted using urban-mined ethical gold.
The recycling process was directed by a scientist at NIMS.

Reverse

Research Summary

The work of the awardees has made comprehensive and pioneering contributions to realizing all-solid-state batteries, which is a key technology in next-generation energy storage, through the development of sulfide-based ion-conducting solid materials and the elucidation of their conduction mechanisms.

Prof. Ryoji Kanno developed crystalline sulfide solid electrolytes, including $Li_{10}GeP_2S_{12}$ (LGPS) and argyrodite-type materials, achieving superionic conductivity at room temperature that significantly exceeds that of conventional liquid electrolytes.

Furthermore, he advanced the understanding of lithium-ion diffusion pathways based on studies of crystal structures and defect chemistry, and established guidelines for designing materials exhibiting high ionic conductivity.

Prof. Masahiro Tatsumisago pioneered amorphous and metastable crystalline materials exhibiting fast ion conduction through the development of ion-conducting glasses and glass-ceramics typified by the Li_2S-P_2S_5 system, thereby establishing a materials foundation for the practical application of sulfide-based solid electrolytes.

Together, their complementary approaches—spanning amorphous to crystalline materials—established comprehensive principles for achieving fast ionic conduction and advanced the understanding of electrode/electrolyte interfaces. These achievements have laid the scientific and technological foundation for high-performance all-solid-state batteries.

Impact on the Academic and Industrial Sectors

The combined contributions of Prof. Kanno and Prof. Tatsumisago have transformed the field of solid-state ionics and energy materials science by integrating seemingly opposing approaches incorporating crystalline and amorphous solids into a unified framework for ion conduction. Their work has significantly advanced the fundamental understanding of fast ion transport and stimulated extensive global research activities, as reflected in the high citations of their publications.

From an industrial perspective, their discoveries have triggered the development of sulfide-based all-solid-state battery technologies, which are being actively studied for applications in electric vehicles, grid-scale energy storage, and portable electronics. Their work has provided essential materials and design guidelines that have accelerated industrial R&D worldwide.

By enabling safer and higher energy-density battery systems, these achievements are expected to play a crucial role in advancing next-generation energy technologies and contribute to the realization of a carbon-neutral society.

Glossary

(1) All-solid-state battery : a next-generation battery that uses solid materials as electrolytes, offering high safety and high energy density.

(2) Sulfide-based materials : materials containing sulfur as a main component, known for their high ionic conductivity in all-solid-state batteries.

(3) Solid electrolyte : a solid material that conducts ions and enables ion transport between electrodes in all-solid-state batteries.

(4) Amorphous material : a material in which atoms are not arranged in a regular, ordered structure.

(5) Crystalline material : a material with a regularly ordered crystal structure of atoms.

Prof. Ryoji Kanno

Institute Professor, Research Center for All-Solid-State Battery,
Institute of Integrated Research, Institute of Science Tokyo



Research Fields

Solid-state chemistry, solid-state ionics, electrochemistry, interfacial analysis

History

1978	Bachelor of Science, Osaka University
1980	Master of Science, Osaka University
1985	Doctor of Science, Osaka University

1980 - 1989	Assistant Professor, Department of Chemistry, Faculty of Engineering, Mie University
1983 - 1984	Bourses du Gouvernement Français, Laboratoire de Chimie du Solide du CNRS, Université Bordeaux 1
1989 - 2001	Associate Professor, Department of Chemistry, Faculty of Science, Kobe University
1991 - 1992	Overseas researcher, Ministry of Education Japan, Oregon State University, USA
1999 - 2001	Associate Professor, High Energy Accelerator Research Organisation
2001 - 2016	Professor, Tokyo Institute of Technology (Tokyo Tech)
2002 - 2003	Professor, Institute for Chemical Research, Kyoto University
2016 - 2018	Associate Dean, Professor, School of Materials and Chemical Technology, Tokyo Tech
2018 - 2021	Professor, Institute of Innovative Research, Tokyo Tech
2021 - 2024	Institute Professor / Director, Research Center for All-Solid-State Battery, Institute of Innovative Research, Tokyo Tech
2024 - Present	Institute Professor / Director, Research Center for All-Solid-State Battery, Institute of Integrated Research, Institute of Science Tokyo

Major Awards

2016	Kato Memorial Foundation Award
2017	The Electrochemical Society, Battery Division Research Award
2018	International Battery Materials Association, Research Award
2021	The Electrochemical Society of Japan, Society Award
2021	Minister of Education, Culture, Sports, Science and Technology Award
2023	44th JSAP Outstanding Paper Award, award for Best Review Paper
2023	the 2023 Suematsu Award “Fundamentals and Developments of Innovative Value Creation”
2026	Fujihara Award
2026	NIMS Award

Major Publications/Books

1) Kanno, R.; T. Hata, Y. Kawamoto and M. Irie, Synthesis of a new lithium ionic conductor, thio-LISICON-lithium germanium sulfide system. Solid State Ionics, 2000, 130(1-2): 97-104.

2) Kanno, R.; Murayama, M., Lithium Ionic Conductor Thio-LISICON: the Li_2S-GeS_2-P_2S_5 System. J. Electrochem. Soc. 2001, 148 (7), A742-A746.

3) Kanno, R.; Murayama, M.; Inada, T.; Kobayashi, T.; Sakamoto, K.; Sonoyama, N.; Yamada, A.; Kondo, S., A Self-Assembled Breathing Interface for All-Solid-State Ceramic Lithium Batteries. Electrochem. Solid-State Lett. 2004, 7 (12), A455-A458.

4) Hirayama, M.; Ido, H.; Kim, K.; Cho, W.; Tamura, K.; Mizuki, J.; Kanno, R., Dynamic Structural Changes at $LiMn_2O_4$/Electrolyte Interface during Lithium Battery Reaction. J. Am. Chem. Soc. 2010, 132 (43), 15268-15276.

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Prof. Masahiro Tatsumisago

Executive Advisor, Osaka Metropolitan University



Research Fields

Inorganic Materials Chemistry, Glass Science, Solid State Ionics

History

1978	Bachelor's Degree, Osaka University
1980	Master's Degree, Osaka University
1984	Doctorate, Osaka University
1980 - 1991	Research Associate, Osaka Prefecture University
1988 - 1989	Postdoctoral Researcher, Purdue University and Arizona State University
1993 - 1996	Associate Professor, Osaka Prefecture University
1996 - 2019	Professor, Osaka Prefecture University
2015 - 2019	Dean, Graduate School of Engineering, Osaka Prefecture University
2019 - 2025	President, Osaka Prefecture University
2022 - 2025	President, Osaka Metropolitan University
2025 - Present	Executive Advisor, Osaka Metropolitan University

Major Awards

1995	Professor V. Gottardi Memorial Prize from the International Commission on Glass
2001	Academic Award of the Ceramic Society of Japan
2002	Academic Award of the Chemical Society of Japan
2018	Academic Prize of the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology of Japan
2019	Chemical Society of Japan Award from the Chemical Society of Japan
2023	Medal with Purple Ribbon from the Decoration Bureau from the Cabinet Office of Japan
2026	Ceramics Grand Prize from the Ceramic Society of Japan
2026	NIMS Award

Major Publications/Books

1) Stabilization of Superionic α -AgI at Room Temperature in a Glass Matrix, Nature, 354 [6350] 217-218 (1991).
2) Superionic Conduction in Rapidly Quenched Li_2S-SiS_2-Li_3PO_4 Glasses, J. Ceram. Soc. Jpn., 101 [11] 1315-1317 (1993).
3) Mechanochemical Synthesis of New Amorphous Materials of $60Li_2S \cdot 40SiS_2$ with High Lithium Ion Conductivity, J. Am. Ceram. Soc., 82 [5] 1352-1354 (1999).
4) Structural Change Accompanying Crystallization in the Lithium Ion Conductive Li_2S-SiS_2-Li_3PO_4 Oxysulfide Glasses, J. Ceram. Soc. Jpn., 107 [6] 510-516 (1999).
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18) A Sulphide Lithium Super Ion Conductor is Superior to Liquid Ion Conductors for Use in Rechargeable Batteries, Energy Environ. Sci., 7, 627-631 (2014).
19) Preparation of Li_3BO_3-Li_2SO_4 Glass-Ceramic Electrolytes for All-Oxide Lithium Batteries, J. Power Sources, 270, 603-607 (2014).
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Abstract
Oral Presentation

NIMS Award Session

“Between Electrochemistry and Materials Science —The Road from Ionic Conductor to Solid-State Batteries—”

Ryoji Kanno
Director and Institute Professor, Research Center for All-Solid-State Battery
Institute of Integrated Research, Institute of Science Tokyo

Abstract

Solid-state batteries are attracting considerable attention because of their potential advantages, including improved reliability and safety, higher energy density and power capability, faster charging, and a wider operating temperature range. The development of new solid electrolytes is a key factor in advancing solid-state battery technology. This presentation reviews our research on lithium-based materials and discusses future challenges and approaches to materials development.

Sulphide-based solid-state batteries are now entering the commercial market and being produced on an increasingly large scale. However, various approaches to solid-state batteries were explored before the emergence of today’s technologies. Our research began with developing of copper-based solid-state batteries and lithium halide solid electrolytes, followed by investigating of sulphide-based systems. These studies led to the discovery of a new class of solid electrolytes, known as Thio-LISICON. $Li_{10}GeP_2S_{12}$ (LGPS)-type materials subsequently demonstrated lithium-ion conductivities exceeding 10^{-2} S cm^{-1}, among the highest values reported for solid electrolytes at the time[1] (see Fig. 1-3). Our research also demonstrated the inherent advantages of solid-state batteries in terms of power performance[2] (Fig. 4).

New materials enable new devices. The development of next-generation solid-state batteries requires advances in both solid electrolytes and electrode materials. Recent developments in solid electrolytes will be reviewed, together with emerging approaches to materials discovery that integrate conventional materials research with advanced computational and experimental techniques. The future challenges and opportunities in the development of materials for next-generation solid-state batteries will also be discussed.

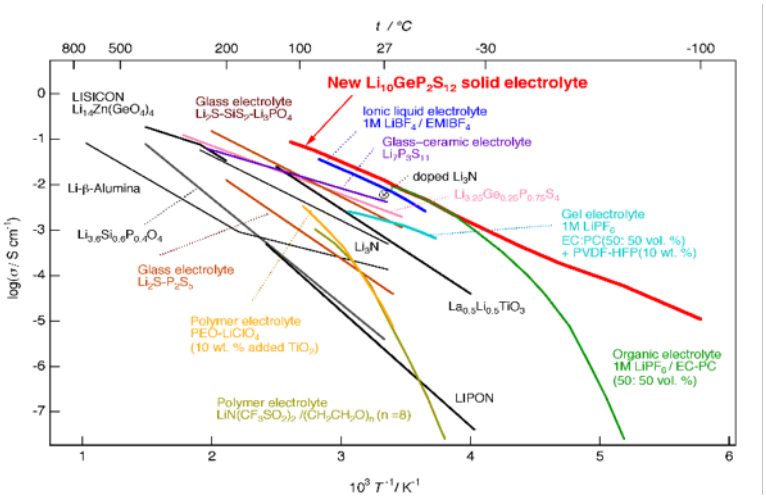


Fig. 1 Thermal evolution of ionic conductivity of the new $Li_{10}GeP_2S_{12}$ phase, together with those of other lithium solid electrolytes, organic liquid electrolytes, polymer electrolytes, ionic liquids, and gel electrolytes[1].

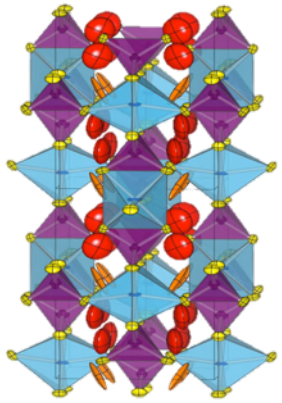


Fig. 2 LGPS Structure[1].

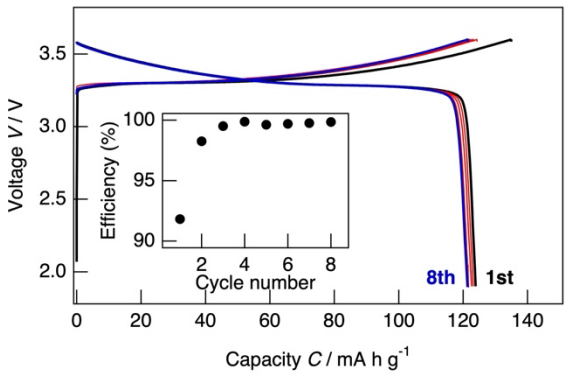


Fig. 3 Charge/discharge curves of an all-solid-state battery consisting of a $LiCoO_2$ cathode, a $Li_{10}GeP_2S_{12}$ electrolyte, and In metal anode. The current density is 14 mA g^{-1}. A discharge capacity of over 120 mAh g^{-1} and an excellent discharge efficiency of ca. 100 % after the second cycle[1].

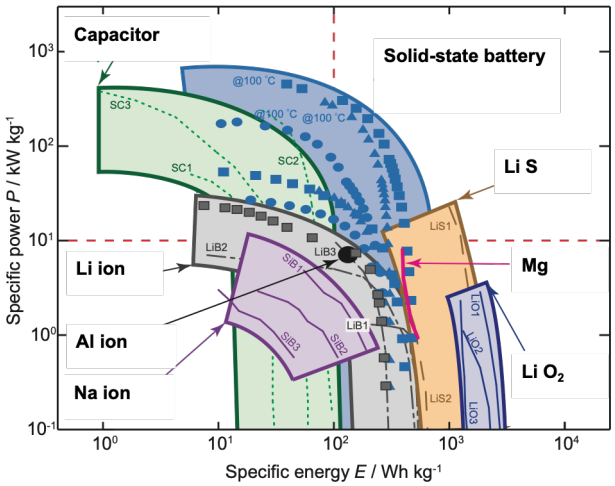


Fig. 4 Ragon plot. Correlation between power output and energy density[2].

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Development of Glass-Based Inorganic Solid Electrolytes for All-Solid-State Batteries

Masahiro Tatsumisago
Executive Advisor, Osaka Metropolitan University

Abstract

Due to the nonflammable property of inorganic solid electrolyte materials and the realization of single ion conduction, all-solid-state batteries using inorganic solid electrolytes are considered one of the ultimate goals of rechargeable energy sources. Our research has focused on the superiority of glassy materials in the solid state ionics field and, as a result, we have created a number of glass-based inorganic solid electrolyte materials possessing high ionic conductivity comparable to that of liquid electrolytes and ease in construction of solid-solid interface. In addition, we have created prototype all-solid-state secondary batteries using those materials and pioneered the way for total solidification in electricity storage devices. All-solid-state lithium secondary batteries for electric vehicles have reached the eve of their commercialization.

In this presentation, I would like to provide an overview of our main research findings regarding the following topics.

1. Fabrication of highly ionic conductive glass-based electrolyte materials

We focused on the open structure of disordered glass in an atomic arrangement, presented guidelines for glass compositions favorable to ionic conduction, and demonstrated numerous examples in experiments. In particular, through the collaboration with Dr. K. Takada, we discovered that oxysulfide glasses in the systems Li_2S-SiS_2-Li_xMO_y (M=Si,P,Ge,S) prepared by rapid melt quenching have high room temperature conductivity exceeding 10^{-3} S cm^{-1} [1] and created a guideline for enhancing ionic conductivity called the "mixed anion effect."

Direct formation of electrolyte particles should be advantageous, so we succeeded in mechanochemical synthesis using a planetary ball mill of various glassy sulfide electrolyte materials like in the system Li_2S-P_2S_5 [2]. We also discovered that highly conductive glass-ceramics could be obtained by subsequent heat treatment [3,4]. For example, new superionic conducting $Li_7P_3S_{11}$ crystals were precipitated from $70Li_2S{\cdot}30P_2S_5$ (mol%) glass, and due to optimization of heat treatment conditions for crystallization and improvement of sinterability, it reached 1.7×10^{-2} S cm^{-1} at room temperature, comparable to the conductivity of organic liquid electrolytes [5].

2. Formation of solid-solid interface for construction of all-solid-state batteries

Unlike conventional batteries, in all-solid-state batteries, electrochemical reactions should occur at the solid-solid interface between the electrode active material and the solid electrolyte. The contact of the solid-solid interface is the key to the success of all-solid-state batteries, and reduction of the interface resistance is the greatest obstacle in all-solid-state batteries [6]. We succeeded in

forming a good interface and greatly reducing the interface resistance by various creative methods. "Interface formation by gas phase and/or liquid phase techniques" is a good example, and we succeeded in obtaining an excellent interface by coating of Li_2S-P_2S_5 based sulfide electrolyte on the surface of electrode active material particles including $LiCoO_2$ by gas phase or liquid phase method [7].

Microscopic observation of various active material-electrolyte interfaces using electron microscope before and after electrode reaction was conducted. The positive electrode composites using $LiCoO_2$ particles coated with the Li_2S-P_2S_5 film were sintered by pressing at room temperature, and an effective ion pathway among the active material particles was formed on their surface [8]. This peculiar phenomenon was named "cold pressure sintering." Since the active material repeatedly changes in volume during charging and discharging, the mechanical properties within the elastic limit of the solid electrolyte material are also important.

3. Fabrication of high energy density all-solid-state lithium secondary batteries

The most promising active materials for all solid-state batteries are elemental sulfur for the positive electrode and metallic lithium for the negative electrode. We have successfully developed a new, high-capacity electrode composite material by ball-milling sulfur, sulfide solid electrolytes, and copper or nanocarbon as conductive additives. Lithium sulfide, which is a discharge product of sulfur, also succeeded as a composite with copper or nano-carbon as well as sulfur [9]. It was revealed that these lithium-sulfur based all-solid-state batteries exhibited excellent charge/discharge cycle performance even at a relatively high current density [10]. By forming thin films of indium, tin, or gold as a buffer layer at the lithium-sulfide electrolyte interface, we have succeeded in significantly improving the charge-discharge performance of all-solid-state batteries using metallic lithium as the anode.

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Abstract
Oral Presentation

Session 1

Invited Talk 1

The Role of Anion Dynamics in Solid State Electrolytes for Solid State Batteries

Linda Faye Nazar
University Distinguished Professor and Senior Canada Research Chair
University of Waterloo, Canada

Abstract

ASSBs are founded on high performance superionic conducting electrolytes, where the important search for new materials hinges on understanding their intrinsic nature. Many strategies have been established for creating, inducing, and/or enhancing ion transport in crystalline and quasi-crystalline sulfides, halides and oxyhalides, while one of the least well understood is that of anion dynamics. While the "paddlewheel" effect has been long recognized, more recently the concept of anion dynamics have been revisited, and terms such as soft-cradle and flex-ion are used to describe the phenomenon. This presentation will focus on recent findings in our laboratory based on experiment complemented by *ab initio* molecular dynamics simulations. It will cover a range of newly developed fast ion Li conductors–spanning "molecularly-designed" 1-D electrolytes; quasi-crystalline 1-D chains; and crystalline 2-D layered phases–where rapid re-orientation of framework anions induces a frustrated energy landscape, impacting conductivity and activation energy.

Our model is supported by the kinetic interplay between lithium-ion mobility and dynamic chloride-anion motion, as demonstrated through our integrated DFT and AIMD simulations in novel Ruddlesen-Popper phases. Time-resolved conditional probability and frequency analyses reveal that lithium-ion migration is correlated with transient, large-amplitude re-orientational motion of the M–Cl coordination environment. As Li ions traverse the 2D energy landscape, flexural wobbling of the Ta–Cl vectors effectively promotes Li diffusion, indicating the "flex-ion" motion is dynamically responsive to lithium-ion migration. More broadly, this work establishes a paradigm for superionic transport based on correlated anion–cation dynamics within chemically flexible layered frameworks. By demonstrating that cooperative framework motion can dramatically induce Li^+ mobility in a structural family previously regarded as a poor ionic conductor, this study challenges conventional assumptions governing fast-ion transport in solids.



Prof. Linda Faye Nazar FRS FRSC OC is a Distinguished University Research Professor of Chemistry at the University of Waterloo, Canada. She is a Fellow of the Royal Society (London), and the Royal Society of Chemistry (UK), a Fellow of the Royal Society of Canada, an Officer of the Order of Canada, and an Adjoint Professor at the Justus Liebig University in Germany. Her research focuses on solid-state ionics and electrochemical energy storage - particularly lithium-ion and beyond lithium-ion batteries; solid-state electrolytes/batteries; and the materials and interfaces that underpin next-generation battery technologies - using a combination of materials synthesis, advanced characterization tools; electrochemistry and modelling. She has co-authored > 315 publications garnering more than 99,000 citations, and 32 patents/patent applications. Prof. Nazar sits on the Advisory Council for Princeton University's Andlinger Center for Energy and the Environment, and is Chief Scientist for the USA DOE Hub, the *Aqueous Battery Consortium*. She has received numerous international honors for her contributions to solid-state electrochemistry and energy-storage materials, including the Royal Society's Hughes Medal (2024); and the Materials Research Society Medal (2020).

Fundamental Researches and Developments of All-Solid-State Batteries in JST-GteX Project

Yasutoshi Iriyama
Professor, Nagoya University

Abstract

The Japan Science and Technology Agency (JST) initiated team-based research on all-solid-state batteries (SSBs) in the ALCA-SPRING program in 2013, with sulfide-based SSB team led by Prof. Tatsumisago of Osaka Metropolitan University (OMU) and oxide-based SSB team led by Dr. Takada of the National Institute for Materials Science.

Building on the great success of ALCA-SPRING, JST launched the GteX in 2023. Within its storage battery area, researches on highly safe batteries was initiated, and two SSB projects started. One is the sulfide-based SSB team led by Prof. Hayashi of OMU, and this team focuses on the development of sulfide-based SSBs with high energy density and high safety, and targets using sulfur-based positive electrodes are shown in Fig. 1a. The other is oxide-based SSB team led by Prof. Iriyama of Nagoya University, and this project focuses on the development of key technologies for three types of SSBs: sintered-type, non-sintered-type, and high-energy-density-type SSBs as shown in Fig. 1b.

The current SSB activities in JST-GteX have been built upon the pioneering contributions of Prof. Kanno of Institute of Science Tokyo, Prof. Tatsumisago, and Dr. Takada to the science and technology of solid electrolytes, reaction mechanism of SSBs, and interface modification. Many researchers who studied in their laboratories are now playing leading roles in these SSB projects and driving significant advances. In this presentation, I will introduce an overview of the research and development activities on SSBs under JST-GteX.

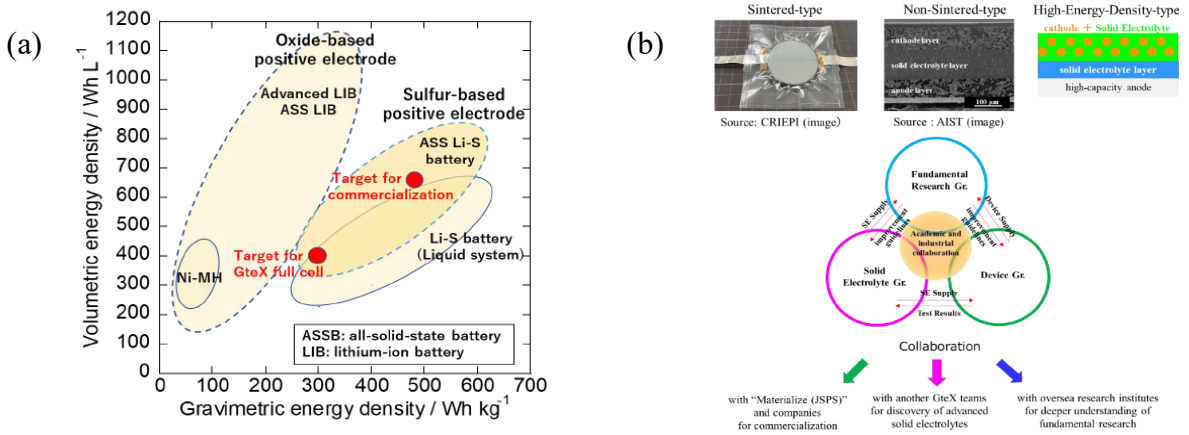


Fig. 1 Targets of SSBs researched under JST-Gtex for (a) sulfide-based SSBs and (b) oxide-based SSBs.



Education
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Assistant Professor Apr., 2001~Mar., 2008 Kyoto University, Japan
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Professor Jan., 2012~ Nagoya University, Japan
Research
Research Fields
All-Solid-State Battery, Interface, Electrochemistry, Solid State Ionics

Invited Talk 3

The Rise of Sulfide-Based Solid-State Batteries and Remaining Challenges

Jürgen Janek

(1) Professor, Institute of Phys. Chemistry & Executive Director, Center for Materials Research,

Justus Liebig University Giessen, Heinrich-Buff-Ring 17, 35392 Giessen, Germany

(2) Director, BELLA–Batteries and Electrochemistry Laboratory, Institute of Nanotechnology, Karlsruhe Institute of Technology, Germany

(3) Distinguished Professor, Institute of Multidisciplinary Research on Advanced Materials, Tohoku University, Sendai, Japan

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Abstract

The key advantages expected from solid-state batteries have changed with time. While originally safety was a strong trigger for SSB research and development, later high specific energy and high specific power came up as major drivers. Meanwhile expectations are as diverse as the various SSB cell concepts–which range from hybrid or multilayer cell concepts to ceramic cell concepts, yet specific energy and power are still top KPIs. Due to the remaining challenges, the timeline of announcements of SSBs as commercial products has continuously shifted, and reliable projection is difficult from the academic perspective.

In this lecture, I will summarize some remaining key issues on the way to high-performance sulfide-type solid-state batteries from my own academic perspective. Own research results will be used to exemplify these issues: First, the construction of high-rate cathode composites and their pressure dependence will be discussed, along with issues of electrochemical stability. The critical role of proper composite mixing will be addressed. Second, the critical role of sufficiently thin separators will be discussed. The self-discharge of SSBs through minor electronic conductivity of the separator electrolyte will be quantified, and the influence of SEI and CEI formation for the lithium inventory will be discussed. Third, the current state of research on the lithium metal anode will be considered and own research on lithium microstructure and interlayers for improved anode operation will be presented.



Prof. Jürgen Janek is professor for Physical Chemistry at Justus Liebig University in Giessen (JLU). Germany, director of the JLU Center for Materials Research, Scientific Director of the BELLA lab at KIT, Karlsruhe. Recently, he also became Distinguished Professor at Tohoku University in Sendai, Japan. He is member of the Leopoldina–German National Academy of Sciences and holds a honorary doctorate from Technical University of Delft, The Netherlands. He holds numerous patents and has published more than 600 peer-reviewed papers. His research interests focus on the physical chemistry of inorganic solids, solid state ionics, specifically on the properties of mixed ionic-electronic conductors, defect chemistry of ionic materials, solid-state reactions and solid-solid interfaces. In recent years his research is focused strongly to battery materials, solid electrolytes, solid-state batteries and operando studies of batteries. He is scientific coordinator of the German Cluster of Competence for Solid State Batteries FESTBATT funded by BMBF (Federal Ministry for Education and Research) since 2019 and is one the spokespersons of the DFG Cluster of Excellence POLIS at Ulm/Karlsruhe/Giessen, funded from 2026 till 2032.

Analysis of Lithium-Ion Transport in Solid-State Batteries by NMR and SIMS

Naoaki Kuwata
Group Leader, Solid State Battery Ionics Group, GREEN, NIMS
Visiting Professor, Grad. Sch. Chem. Sci. Eng., Hokkaido University

Abstract

Understanding lithium-ion transport is essential for the development of solid-state batteries. Macroscopic ionic conductivity measurements cannot directly distinguish microscopic diffusion in bulk materials, grain boundaries, and heterointerfaces. We have therefore developed complementary approaches using nuclear magnetic resonance (NMR) and isotope-sensitive secondary ion mass spectrometry (SIMS) to quantitatively investigate lithium-ion transport.

Pulsed-field-gradient NMR (PFG-NMR) directly measures lithium self-diffusion, while $^{6}Li/^{7}Li$ isotope exchange combined with time-of-flight SIMS (TOF-SIMS) provides spatially resolved concentration profiles for determining diffusion coefficients. Figure 1 shows an example for single-crystalline $La_{(1-x)/3}Li_xNbO_3$, where diffusion coefficients obtained by PFG-NMR, isotope-exchange TOF-SIMS, and ionic conductivity show good agreement over a wide temperature range. This comparison directly relates microscopic lithium diffusion to macroscopic ion transport.

These approaches can be extended to heterogeneous battery materials and interfaces. Isotope-exchange TOF-SIMS enables spatially resolved analysis of lithium transport across grain boundaries and heterointerfaces, while operando SIMS visualizes lithium redistribution in composite electrodes during electrochemical operation. Combining NMR, isotope tracer SIMS, and operando SIMS provides complementary information on lithium-ion transport from microscopic diffusion to working battery materials.

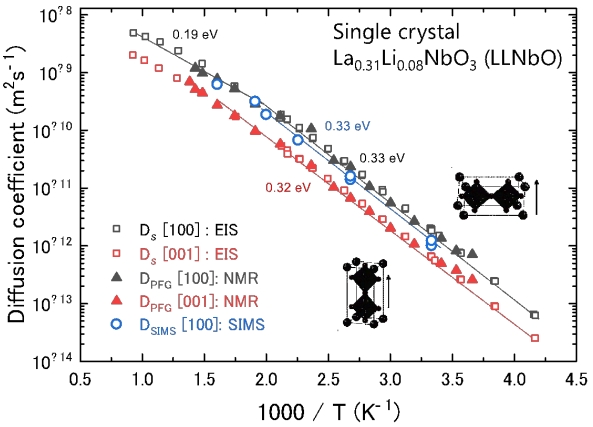


Fig. 1. Comparison of lithium diffusion coefficients determined by PFG-NMR (D_{PFG}), isotope-exchange TOF-SIMS (D_{SIMS}), and ionic conductivity (D_σ) for single-crystalline $La_{(1-x)/3}Li_xNbO_3$,



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Abstract
Oral Presentation

Session 2

Invited Talk 4

Finding Strength in Softness — On the Path to Durable Solid-State Batteries

Stefan Adams
Associate Professor, National University of Singapore

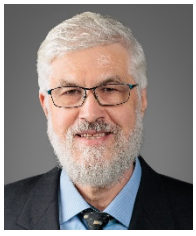
Abstract

A key motivation in the design of advanced solid electrolytes over the past decades has been to enable safe, long-lasting, high-performance solid-state batteries. Beyond the race for record ionic conductivities, it is therefore essential to develop lightweight catholytes and anolytes that combine fast-ion conduction with electrochemical and mechanical compatibility with high-energy electrode materials. High durability does not necessarily arise from the ability to resist change, but sometimes from the ability to accommodate change without losing function. Selected approaches toward this goal will be discussed by tailoring the softness of electrolyte materials, from atomic-scale polarizability to macroscopic mechanical compliance.

An all-inorganic approach exploits the intricate relationship between ionic conductivity and glass-forming ability. This concept is exemplified by halogen-doped glass-ceramic sulfides and oxyhalides with ionic conductivities of the order of 10 mS cm^{-1}. Pressure-dependent measurements and simulations reveal exceptionally high compressibility combined with low activation volumes, demonstrating the robustness of their ion-migration pathways against mechanical deformation. Synergizing these soft inorganic solids in NCM811|oxyhalide|argyrodite|Li–In dual-electrolyte cells enables remarkably durable cycling, with cycle lives of up to 12,000 cycles. At room temperature, cells retain >93.9% of their initial capacity over 3,000 cycles at 2C, with nearly the same capacity retention achieved at high loading and a current density of 7.6 mA cm^{-2}.

As an alternative route toward compliant solid electrolytes, ceramic-in-polymer composites exploit surface-active nanoceramics to enhance ionic conductivity and mechanical strength while retaining wide electrochemical windows and ease of processing. Percolating networks of fast-conducting interphases enable conductivities of 1.8 mS cm^{-1} at densities approaching those of liquid electrolytes. With LFP cathodes, they deliver 165 mAh g^{-1} and robust cycling up to 10C, retaining >80% capacity after 200 cycles; in NMC pouch cells >95% capacity is retained after 200 cycles at 0.5C.

Together, these examples illustrate how embracing softness across length scales can serve as a guiding principle for designing long-lasting, high-performance solid-state batteries.



After his PhD from Saarbrücken/Germany, **Prof. Stefan Adams** worked at the Max-Planck Institute for Solid State Research in Stuttgart and habilitated from Göttingen University before joining National University of Singapore in 2005, where he is Assoc. Professor for Materials Science and Eng. His research focuses on rational design of inorganic materials and interfaces for optimal transport properties in energy storage devices. To this end his group combines electrochemical, diffraction and spectroscopic experiments with high-throughput computations. Electrolytes designed in his group are integrated into high energy density solid state batteries by a start-up company. Adams also serves as Treasurer of the International Society for Solid State Ionics, editorial board member of several related journals and has been Vice-President of the Materials Research Society of Singapore as well as Secretary of the Asian Society for Solid State Ionics.

Development of Next-Generation All-Solid-State Battery Assessment and Enabling Technology in SOLiD-Next Project

Yosuke Fukuyama

Division Manager, Research Division 2, Department of commissioned project

Consortium for Lithium Ion Battery Technology and Evaluation Research Center (LIBTEC)

Abstract

The SOLiD-Next project (NEDO, FY2023–2027) is dedicated to the social implementation of all-solid-state lithium-ion batteries, pursuing three objectives: enhancement of battery durability, science-based elucidation of degradation mechanisms, and establishment of standardized reference cells (“measuring stick” cells) for material evaluation. The work is carried out through an all-Japan framework encompassing automotive, battery material, analytical instrument, and production equipment companies, along with universities and national research institutes. As of the interim review, three reference cell models had been established. Furthermore, demonstration cells achieved a capacity retention of 93% (under 20 MPa constraint pressure) in durability tests corresponding to 100,000 km of EV driving, substantially exceeding the interim target of 70%. Toward the final targets, the most critical remaining challenge is to reduce the constraint pressure to a level acceptable for practical EV battery packs. In particular, the simultaneous realization of fast-charging capability and long-term durability equivalent to 300,000 km of driving under such low constraint pressures constitutes the key scientific and engineering challenge. In the latter half of the project, the outcomes of fundamental technology development will be integrated toward achieving the final targets, and evaluation platforms for next-generation materials will be established. Consequently, the global competitiveness of the battery industry in 2030 and beyond can be secured. In this presentation, an overview of the project will be given together with several selected topics based on results obtained to date.

Acknowledgement

This work is based on the project of ‘Evaluation of All-Solid-State Battery Material and Foundational Technology Development for Next Generation (SOLiD-Next, JPNP23005)’, commissioned by the New Energy and Industrial Technology Development Organization (NEDO).



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In 2005, he joined Nissan Motor Co., Ltd. and conducted PEMFC and SOFC research and development as EV power sources for nearly two decades. In R&D project, he conducted the research as a visiting scientist in The Pennsylvania State University from 2007 to 2009, and worked at Automotive Fuel Cell Cooperation (Joint venture of Daimler and Ford in Canada) to advance the project in 2013. He has taken on the role of senior manager in research center in Nissan Motor Co., Ltd. since 2017.
He has held his current position in LIBTEC and has led the Cell and Process Division of all-solid-state batteries since 2026.

Connecting Material Properties with Battery Performance

Kazunori Takada
Fellow, National Institute for Materials Science

Abstract

Solid-state batteries are regarded as a promising candidate for energy storage in the coming low-carbon society. Single-ion conduction in solid electrolytes suppresses side reactions taking place in rechargeable batteries and provides high reliability required for vehicle and stationary applications. The most important materials for realizing high-performance solid-state batteries are indeed solid electrolytes with high ionic conductivity. The highest ionic conductivity among lithium-ion conductors has exceeded 10^{-2} S cm^{-1} in sulfide systems [1, 2], which is higher than that of organic-solvent liquid electrolytes used in lithium-ion batteries. The highest conductivity in oxides had been around 10^{-3} S cm^{-1}, and it has also reached 10^{-2} S cm^{-1} recently in an oxyfluoride with pyrochlore-type structure [3]. However, such high ionic conductivity does not lead to high battery performance without connection between the battery materials through interfaces exhibiting fast ionic conduction.

Sulfide-based solid-state batteries showed high resistance at their cathode/solid electrolyte interface. A thin-film oxide electrolyte layer has successfully lowered the rate-determining resistance [4] to provide enough performance for vehicle application to the sulfide systems. On the other hand, oxide-based solid-state batteries that are usually assembled by sintering process show high resistance at grain boundaries as well as electrode/electrolyte interfaces; the former originate from poor connection between the electrolyte particles and the latter from impurities formed during the sintering process. High sintering temperature is necessary to decrease the grain boundary resistance, whereas it should be lowered to suppress the impurity formation, which is a dilemma to work out in the battery development.

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Dr. Kazunori Takada is a Fellow at NIMS, Japan. He began his career at Matsushita Electric Industrial Co., Ltd. in 1986 and started his research on solid-state batteries. He moved to Matsushita Battery Industrial Co., Ltd. and received his Doctor of Engineering degree from Osaka City University in 1991. In 1999, he joined the National Institute for Research in Inorganic Materials, a predecessor of NIMS. After serving as Director of the Center for Green Research on Energy and Environmental Materials, he was appointed NIMS Fellow in 2023. His research focuses on solid electrolytes and electrode–electrolyte interfaces for solid-state batteries.

Abstract
Poster Presentation

- P1. Battery and Cell Materials Fiweld [P1-01~P1-51]
- P2. Hydrogen Technology Materials Field [P2-01~P2-24]
- P3. Others [P3-01~P3-12]

P1-01

Revisiting Ethylene Carbonate: A Self-Limiting Cathode Interphase for High-Voltage Li|Li_2RuO_3 Cells

Arghya Dutta, Shoichi Matsuda
Research Center for Energy and Environmental Materials (GREEN), NIMS

Ethylene carbonate (EC) is usually excluded from high-voltage electrolytes as too oxidatively unstable, yet its true effect on the cathode-electrolyte interphase (CEI) has stayed unclear. Using a decoupled dual-electrolyte cell that confines carbonate oxidation to a Ni-/Co-free Li_2RuO_3 cathode at 4.5 V, we find EC outperforms PC and FEC, retaining 79% capacity over 30 cycles and forming the thinnest, most uniform CEI. Interphasial characterizations supported by DFT calculations show oxidized EC oligomerizes into a compact, self-limiting film, whereas PC and FEC generate fragmented products. Post-oxidation reaction pathways, not oxidative stability alone, govern high-voltage electrolyte performance.

P1-02

Mitigation of Chemical Crossover in High-Voltage LRO Lithium Metal Cells Using Li-ion Conducting Barrier

Arpita Das, Arghya Dutta, Shoichi Matsuda
Research Center for Energy and Environmental Materials (GREEN), NIMS

Lithium ruthenium oxide (LRO) cathodes offer high energy density through combined cationic and anionic redox but suffer from severe capacity and voltage degradation during high-voltage cycling. Here, we investigate electrode crosstalk as a degradation pathway in high-voltage LRO lithium-metal cells using an inorganic Li-ion conducting (OHARA) barrier. At 4.5 V, the OHARA-containing cell retains ~84% capacity compared with ~60% for the standard cell. XCT reveals substantially reduced anode interphase growth, while gas analysis shows suppressed CH_4, C_2H_4, and C_2H_6 evolution. XRD further indicates comparatively preserved cathode structural integrity after cycling. These results demonstrate that restricting chemical crossover effectively mitigates interfacial degradation and improves LRO cell stability.

P1-03

Deciphering Intertwined Kinetic and Transport Limitations of Practical-Level Lithium Iron Phosphate Cathodes

Hong Rim Shin, Shoichi Matsuda
Research Center for Energy and Environmental Materials (GREEN), NIMS

We identify the bottleneck limiting high-rate performance of practical-level LFP cathodes through a combined experimental–modeling study. A physics-based half-cell model reveals electrode-level electronic transport, rather than particle-scale processes (e.g., interfacial reaction and solid-state diffusion), as rate-limiting, confirmed by experiments with practical-level pouch cells.

P1-04

Physicochemical Characterization of Amide-Based Electrolytes for Lithium–Oxygen Batteries

Manai Ono[1], Shoichi Matsuda[2]
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[2] Research Center for Energy and Environmental Materials (GREEN), NIMS

Lithium–oxygen batteries (LOBs) require highly stable electrolytes for practical applications. In this study, amide-based electrolytes were investigated as candidate electrolyte systems for LOBs. Raman spectroscopy, infrared spectroscopy, and NMR spectroscopy were employed to examine intermolecular interactions and Li^+ coordination environments. Physicochemical properties were evaluated by impedance measurements, while differential scanning calorimetry was used to assess the formation of deep eutectic solvents in selected compositions. Differences in coordination structures were observed among the electrolyte systems, indicating that composition strongly influences solution structure and physicochemical properties. These findings provide insights into the design of amide-based electrolytes for LOBs.

P1-05

Closed-Loop Bayesian Optimization of Electrolyte Additives for Sodium-Ion Batteries

Shu-Chi Wu, Arghya Dutta, Shoichi Matsuda*
Research Center for Energy and Environmental Materials (GREEN), NIMS

An autonomous closed-loop platform integrating robotic high-throughput testing and data-driven optimization was developed to accelerate sodium-ion battery electrolyte discovery. Screening only 3.6% of 32,805 candidates identified a ternary additive electrolyte that achieved an average Coulombic efficiency of 99.74% over cycles 91–100. XPS and cryo-TEM revealed a thin, uniform, NaF-rich hybrid SEI.

P1-06

Lithium-Anode Accessibility Alters the Downstream Evolution of TEGDME-Derived Products in Li-O_2 Batteries

Yanan Gao, Manai Ono, Shoichi Matsuda
Research Center for Energy and Environmental Materials (GREEN), NIMS

Lithium-anode accessibility can influence the fate of electrolyte-derived intermediates in Li-O_2 batteries. Here, operando cold-trap pre-concentrator gas chromatography/mass spectrometry (CTPC-GC/MS) was used to compare cells with exposed and ceramic-protected Li-metal anodes. Twenty eight TEGDME-derived products were detected during cycling, with most showing lower cumulative responses when direct access to Li metal was restricted. In contrast, methanol and 2-methoxyethanol were more persistent in protected cells. These results demonstrate that the Li anode actively redirects the downstream evolution of electrolyte-derived species, revealing cross-electrode degradation as an important pathway in Li-O_2 batteries.

P1-07

Accelerating $LiMn_2O_4$ Kinetics via Equimolar Multi-Element Doping

Monira Parvin[2], Arghya Dutta[1], Shoichi Matsuda[1], Surendra Kumar Martha[2]
[1] Research Center for Energy and Environmental Materials (GREEN), NIMS
[2] IIT Hyderabad

High-entropy spinel $LiMn_2O_4$ (HELMO) exhibits significantly enhanced electrochemical performance and structural stability compared to conventional spinel $LiMn_2O_4$ (LMO). While LMO enables rapid 3D Li-ion transport for fast-charging lithium-ion batteries, its cycling life suffers from capacity fade caused by Jahn-Teller distortion. To overcome this, HELMO was engineered by substituting manganese sites with an equimolar blend of five cations: Al^{3+}, Ti^{4+}, Zn^{2+}, Cu^{2+}, and Ni^{2+}. At a high 5C rate, HELMO delivers a superior capacity of 95 mAh g^{-1} compared to LMO's 85 mAh g^{-1}, while achieving a 100% peak coulombic efficiency and a 98.5% average.

P1-08

Uncovering the Electrochemical Lithiation Characteristics of Silicon Anodes in All-solid-state Lithium-ion Batteries: A Study Using Single-crystal Silicon Model Electrodes

Ridwan Pratama Putra[1,2], Daisuke Ito[3], Takuya Masuda[1,2]
[1] Research Center for Energy and Environmental Materials (GREEN), NIMS
[2] Hokkaido University
[3] Murata Manufacturing Co., Ltd.

Silicon has gained widespread attention as an anode material for all-solid-state lithium-ion batteries (ASSLIBs) because of its dramatically high theoretical capacity density. Unfortunately, its severe volume fluctuations associated with electrochemical lithiation/delithiation can trigger cascading mechanical and electrochemical degradation issues. Single-crystal Si (c-Si) can serve as an ideal model for tracking anisotropic lithiation/delithiation behaviors in Si. Here, we investigated the electrochemical lithiation characteristics of Si anodes using c-Si model electrodes with different surface orientations of (110), (100), and (111) assembled under an ASSLIB configuration. The microstructures and surface chemical species formed in the lithiated c-Si electrodes were evaluated using various techniques.

P1-09

Operando X-ray Photoelectron Spectroscopy Study on a SiO_x Thin-Film Electrode on a $Li_{6.6}La_3Zr_{1.6}Ta_{0.4}O_{12}$ Solid Electrolyte

Tsukasa Iwama[1,2], Ryosuke Sugimoto[3], Raimu Endo[1,2], Tsuyoshi Ohnishi[2], Masakazu Haruta[4], Takayuki Doi[3], Takuya Masuda[1,2]
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[3] Doshisha University
[4] Kindai University

Electrochemical lithiation/delithiation processes of a $SiO_{0.5}$ thin film were investigated by operando X-ray photoelectron spectroscopy (XPS). Si and SiO_x surface peaks remained unchanged up to ~1300 mAh/gSi, but Li_ySi (y = ~2.0) and Li-silicates peaks appeared at ~1400 mAh/gSi simultaneously with a decrease in the Si and SiO_x peaks. These results indicate that the initial lithiation of $SiO_{0.5}$ occurred at the vicinity of the $SiO_{0.5}/Li_{6.6}La_3Zr_{1.6}Ta_{0.4}O_{12}$ interfaces, beyond the probing depth of surface-sensitive XPS, and gradually propagated into the bulk, thereby elongating the ion conductive pathways composed of the $Li_{\sim 2.0}Si$. Thereafter, the Li_ySi peak shifted reversibly with the state of charge, demonstrating spatially-uniform lithiation/delithiation throughout the thin-film electrode.

P1-10

Determining Battery Material Performance through Real-Time Synthesis Tracking

Kei Kubota
Research Center for Energy and Environmental Materials (GREEN), NIMS

Battery performance is heavily determined by how electrode materials are synthesized. To understand this "birth" process, we established an innovative in-situ diagnostic method to observe the synthesis of layered oxide materials in real time. Using this technique, we successfully captured the critical, irreversible structural changes that occur under high temperatures during synthesis. These direct observations establish crucial design guidelines to engineer longer-lasting, high-performance battery materials. Unlocking these formation pathways provides a powerful tool for material design, ultimately driving significant advancements in next-generation sustainable energy storage.

P1-11

Investigation of the Li chemical state inside batteries using XRS: Attempts to obtain Li K XANES within battery cells and remaining issues.

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[1] Research Center for Energy and Environmental Materials (GREEN), NIMS
[2] NSRRC(SPring-8)

X-ray Raman scattering (XRS, NIXS), which utilises hard X-rays as a probe, is an analytical method capable of yielding spectra equivalent to the K-edge absorption of light elements, including lithium, and thus enables the 'in situ' investigation of the chemical state of lithium within battery cells. In this study, we report that, by increasing the incident energy at SPring-8 BL12XU, damage to the sample was significantly reduced; furthermore, through the optimisation of the inelastic X-ray scattering spectrometer, we have confirmed for the first time that it is possible to distinguish between Li and Li_2O_2 in situ within a Li–O_2 battery cell.

P1-12

Co-sintering reaction analysis of cathode materials ($LiFePO_4$・$LiNiPO_4$) and oxide-based solid electrolyte $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$

Shuhei Kobayashi[1,2], Kei Kubota[1,2], Fumihiko Ichihara[1], Machiko Ode[3], Shogo Miyoshi[1], Takuya Masuda[1,2]
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[3] Research Center for Structural Materials, NIMS

Oxide-based all-solid-state batteries offer advantages such as higher safety, longevity, and reliability compared to liquid-based systems. However, well-defined electrode/electrolyte interfaces are essential for their realization, requiring a deep understanding and control of interfacial reactions. In this study, $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ (LATP) solid electrolyte and either $LiFePO_4$ (LFP) or $LiNiPO_4$ (LNP) cathode materials were co-sintered under various conditions. The reaction products were quantitatively analyzed and compared to thermodynamically predicted stable phases. Factors leading to discrepancies and improvements in predictive accuracy were also investigated.

P1-13

Correlating the Surface Chemistry of Hard Carbon with Its Stability toward Humid Air Exposure

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Hard carbon (HC) powders for sodium-ion batteries are often processed and stored under ambient laboratory conditions, where moisture exposure is unavoidable. Here, sucrose-derived HCs carbonized at different temperatures were investigated to clarify the effects of humid-air storage on the surface chemistry and electrochemical performance of HC. Humid air exposure was found to cause decreased ICE and reversible capacity, regardless of carbonization temperature. Temperature-programmed desorption coupled with mass spectrometry (TPD-MS) revealed increased desorption of H_2O- and oxygen-containing functional groups, indicating moisture-induced surface modifications. Post-exposure heat treatment was further investigated as a potential approach to recover the electrochemical performance of moisture-exposed HCs.

P1-14

Single-Particle Modeling of Electrolyte-Dependent Charge-Transfer and Lithium Transport in NCM Cathodes

Agnesia Permatasari, Kei Nishikawa
Research Center for Energy and Environmental Materials (GREEN), NIMS

Electrolyte chemistry strongly influences lithium transport and reaction kinetics in Ni-rich NCM cathodes. However, these effects are difficult to distinguish in composite electrodes, where additives and pore structures can influence intrinsic behavior. Here, single particle pulse charge–discharge measurements are combined with numerical modeling to investigate NCM523, NCM622, and NCM811. Two electrolytes, $LiClO_4$ and LiFSI in EC: PC, are compared at depths of discharge. Pulse responses are analyzed using Tafel relationships, while a one-dimensional spherical model incorporating diffusion and Butler–Volmer kinetics reproduces voltage responses. Exchange current density and lithium diffusion coefficients are extracted, revealing electrolyte and material dependent behavior.

P1-15

Development of an Environmental Cell TEM Holder with Photo-Illumination Function

Masaki Takeguchi, Ayako Hashimoto
Research Center for Energy and Environmental Materials (GREEN), NIMS

We have developed a micro-LED integrated environmental cell TEM holder for in situ TEM studies of photocatalysts, which enables light illumination of samples in vacuum, gas, and liquid environments. The optical power density measured at a distance of 25 mm from the LED was approximately 38.4 $\mu W/cm^2$ with a 20 mA current applied. This corresponds to 6.1 mW/cm^2 at the sample position, assuming a 2 mm distance between the sample and the LED within the environmental cell.

P1-16

Bridging the Missing Process–Structure Link in Pt-CeO_2 Nanostructures Using Transfer-Learned STEM Representations

Swati Singh, Ayako Hashimoto
Research Center for Energy and Environmental Materials (GREEN), NIMS

Microstructural organization is a critical determinant of material performance, yet quantitatively predicting the resulting structure from synthesis conditions remains challenging. In this study, Pt-CeO_2 nanostructures synthesized under varying temperatures and gas ratios were investigated, yielding a diverse range of microstructural morphologies. Transfer learning was employed to extract structural representations directly from STEM images without manual feature engineering. The learned representations enabled identification of distinct morphology families and quantitative mapping between synthesis conditions and microstructural organization, achieving high predictive accuracy (R^2 = 0.956). These results demonstrate a data-driven framework for understanding and predicting process-structure relationships in complex materials systems.

P1-17

Evaluation protocol of Mg plating activity in ethereal and non-ethereal electrolyte solutions

Toshihiko Mandai
Research Center for Energy and Environmental Materials (GREEN), NIMS

Rechargeable magnesium batteries are a prospective option for large-scale energy storage applications owing to many advantageous characteristics of magnesium metal. However, absence of suitable electrolyte solutions those satisfy all requirements for sustainable battery operation hampers their practical materialization. To clarify the potential components applicable to magnesium batteries, compatibility of non-aqueous electrolyte solutions with Mg plating is examined systematically. By combining electrochemical measurements and analytical validation techniques, a reliable evaluation protocol of Mg plating activity in electrolyte solutions is proposed to forester informed research environment for a future study.

P1-18

Design of Oxide-Based Positive Electrode Materials with One-Dimensional Ion Diffusion Pathways

Reona Iimura, Toshihiko Mandai
Research Center for Energy and Environmental Materials (GREEN), NIMS

Multivalent-metal batteries using Mg or Ca metal negative electrode have attracted considerable attention as next-generation energy-storage systems because of their resource abundance, safety, and high energy density. Their practical realization requires the development of high-energy oxide positive electrode materials that operate reversibly at room temperature. In this study, we focus on Mn- and Mo-based tunnel-structured oxides featuring one-dimensional ion diffusion pathways. Their electrochemical properties are systematically evaluated, and structural analyses of the host frameworks are performed to clarify the relationship between electrochemical behavior and structural chemistry.

P1-19

Structure–Electrochemical Property Relationship of Weakly Coordinated Anion-Based Electrolytes

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Rechargeable batteries utilizing metallic electrodes as active materials are being developed as next-generation energy storage devices. Non-aqueous electrolytes based on ate-complex-type weakly coordinated anions (WCA) have attracted significant attention because of their promising electrochemical performance especially in multivalent metal-based battery fields. Owing to their structural flexibility, a wide variety of WCAs has been explored, however, the structure-electrochemical property relationship in the WCAs remains unclear possibly because structural characteristics have a large impact on the various mutually-related properties. To gain the fundamental insights of WCAs, we herein designed a series of group XIII element-based WCAs and investigated the electrochemical and transport properties of the corresponding electrolyte solutions with respect to the elemental characteristics of the group XIII elements and the steric geometry of the anions.

P1-20

Dual-Metal Pre-Intercalation for Highly Reversible $VOPO_4$ Cathodes with Suppressed Vanadium Dissolution in Aqueous Zinc-Ion Batteries

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Rechargeable aqueous zinc-ion batteries (ZIBs) offer safety, sustainability, and high energy density, but their practical application is hindered by a scarcity of high capacity with long-term cyclability. Herein, we report an interlayer engineered $VOPO_4$ cathode through dual metal pre-intercalation that shows enhanced structural integrity, mitigates vanadium dissolution and improves overall electrochemical performance. The electrode delivers a high discharge capacity of >200 mAh g^{-1} at 0.1 A g^{-1} and exhibits excellent rate capability and superior cycling performance over 1000 cycles at 1 A g^{-1}. This dual metal-ion pre-intercalation demonstrates a viable strategy for enhancing multivalent-ion storage in the aqueous ZIB system.

P1-21

Sequential Two-Step Solution Processing of Wide-Bandgap Perovskite Solar Cells for Tandem Applications

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Wide-bandgap (WBG, >1.65 eV) perovskite solar cells are promising top cells for tandems with silicon, organic, or tin-lead bottom cells because of their high open-circuit voltage. However, further improvements in film quality, interfaces, and reproducibility are required. Sequential two-step processing offers good film quality and process control but remains less explored for WBG perovskites, partly due to poor bromide diffusion. In this work, WBG perovskite solar cells are fabricated by two-step processing, systematically investigating precursor composition, bromine content, processing conditions, and surface passivation to improve photovoltaic performance.

P1-22

Interface-Guided Buried Interface Enables Efficient and Stable Pb-Sn Mixed Perovskite Solar Cells

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[2] University of Tsukuba

Lead–tin mixed perovskite solar cells are attractive bottom cells for all-perovskite tandem solar cells. However, buried-interface defects, lattice instability, and the acidity and hygroscopicity of PEDOT:PSS promote non-radiative recombination, ion migration, and poor film formation. Here, we introduce a thin molecular interlayer between PEDOT:PSS and the perovskite. Its functional groups passivate undercoordinated Pb^{2+}/Sn^{2+}, reduce interfacial acidity, and improve crystallization. The molecular field created by this molecule also stabilizes the lattice and suppresses phase segregation. As a result, the optimized device achieves 24.21% efficiency, a Voc of 0.90 V, and an FF of 82.8%, and exhibits excellent operational stability.

P1-23

In-operando Techniques to Quantify Gas Generation and Deposition/Stripping Processes on Zinc Electrodes

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Gas generation and dendrite formation are two critical processes that are occurring on Zn electrodes during charge and discharge. However, there are not many simple methods to quantify the amount of gas generated as well as visualize the deposition/stripping processes. In this study, we developed an in-operando thickness measurement technique and an in-operando optical microscopy to monitor the two processes in real time. Zn-Zn symmetry cells with $ZnSO_4$-based electrolytes show that gas starts to evolve with cycling, and the rate of gas generation increases with cycle number. The stripping and deposition processes are found to be asymmetrical, where larger pits are observed during stripping and gas bubbles are observed from the pits.

P1-24

Influence of Image Preprocessing and Segmentation Settings on the 3D Reconstruction of a Battery Electrode from FIB-SEM Images

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Three-dimensional reconstruction of battery electrodes from FIB-SEM images depends on how the image stack is processed and segmented. In this study, we examine how selected preprocessing methods and segmentation settings affect the reconstructed microstructure within the same region of interest. We compare representative image slices, segmentation boundaries, and three-dimensional visualizations across processing conditions. This comparison highlights differences introduced by the analysis workflow and assesses the preservation of fine structural features, without assuming that a visually smoother reconstruction more accurately represents the electrode.

P1-25

Investigation of carbon and Sn-based alloy composites with ether-based electrolytes for sodium-ion batteries

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Sodium-ion batteries are promising for large-scale energy storage, with hard carbon (HC) being a practical anode material due to its cycling durability. However, the limited capacity of HC motivates incorporating high-capacity alloy-type materials, which often suffer from substantial volume changes. Here, HC/SnSb composite anodes with varying ratios were investigated in a diglyme-based electrolyte to examine the effects of electrode composition on electrochemical and dimensional behavior. In particular, operando electrochemical dilatometry tracked electrode thickness changes during cycling, revealing composition-dependent expansion and distinct dimensional signatures associated with Na-storage reactions. Additional characterization of the electrodes and cells will be presented at the symposium.

P1-26

Inducing reconstruction of Li-rich layered oxides to improve electrochemical performance of $Li_{1.2}Ni_{0.2}Mn_{0.6}O_2$

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Li-rich Mn-based layered oxides (LRMOs) are considered one of the promising cathode materials due to their high specific capacity and working potential. However, their relatively low initial Coulombic efficiency (ICE), unsatisfactory rate performance, and poor cycling stability caused by irreversible phase transition and anionic redox during the cycling process hinder their practical application. Herein, a $Li_{1.2}Ni_{0.2}Mn_{0.6}O_2$ cathode containing Li^+ vacancies and Li/Ni anti-sites was constructed through high-energy ultrasonic treatment combined with secondary heat treatment. The synergistic effect of defects can enhance the anionic oxygen reaction of $Li_{1.2}Ni_{0.2}Mn_{0.6}O_2$, inhibit the irreversible phase transition, thus significantly improving the electrochemical performances of $Li_{1.2}Ni_{0.2}Mn_{0.6}O_2$.

P1-27

Highly-porous carbon nanotube sheet for High-Power Lithium-Air Battery

Akihiro Nomura
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LAB develops high energy density energy storages, exceeding 5-10 times higher energy density than that of Lithium-ion battery (LiB) technology, which can be a power source for UAVs that attain a flight time of 1 hour or more. Despite that, the poor rate performance of LABs hinders the practical development. Highly-porous, air breathable cathodes dramatically enhance the rate capability of LABs.

P1-28

Ionic Mass Transfer during Electrodeposition and Dissolution of Li Metal

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The morphology of electrodeposited metals is governed by ionic mass transport in electrochemical systems. In this study, we focus on Li^+ mass transport near the electrode surface to elucidate the mechanisms responsible for morphological changes in electrodeposited lithium metal. Holographic interferometry was employed to visualize concentration profiles during electrochemical reactions, enabling quantitative evaluation of mass transport parameters.

P1-29

High-Capacity Mn-Based Disordered Rocksalt Cathodes for All-Solid-State Lithium Batteries

Marcela Calpa, Randy Jalem, Shoichi Matsuda, Kei Kubota, Naoaki Kuwata, Kazunori Takada
Research Center for Energy and Environmental Materials (GREEN), NIMS

Mn-based disordered rocksalt (DRX) cathodes are promising high-capacity electrode materials because of their reduced reliance on critical elements. In this work, we investigate Mn-based DRX cathodes for all-solid-state lithium batteries, with emphasis on the effects of composition and transition-metal substitution on electrochemical performance. Using sulfide solid electrolytes, selected Mn-based DRX compositions deliver high reversible capacities and improved cycling stability. These results highlight the potential of compositionally optimized Mn-based DRX materials as sustainable, high-capacity cathodes for next-generation all-solid-state batteries.

P1-30

Understanding Interfacial, and Electrolyte Degradation of $LiNbO_3$-Coated Li_2RuO

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Li-rich Li_2RuO_3 is a high-capacity cathode for all-solid-state batteries, but anionic redox drives lattice-oxygen release and interfacial degradation that limit its use. This study addresses how that degradation evolves spatially and chemically at the cathode-electrolyte interface, which remains understudied. Using ToF-SIMS across states of charge, we track evolution of the $LiNbO_3$ coating and the argyrodite electrolyte in contact with the cathode, revealing P-O oxidation and Ru/Nb spatial decorrelation that intensify with delithiation despite the coating's chemical presence. These trends are corroborated by impedance spectroscopy (EIS/DRT), operando gas evolution, and Raman spectroscopy, identifying ToF-SIMS as a sensitive probe of interfacial degradation.

P1-31

Operando Time-of-Flight Secondary Ion Mass Spectrometry Visualization of Reversible and Irreversible Reactions in Oxide-Based Solid-State Batteries

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Operando time-of-flight secondary ion mass spectrometry (TOF-SIMS) was applied to solid-state batteries (SSBs) to visualize the dynamic electrode reactions. The SSBs consist of a $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ (NCA) composite positive electrode, a $Li_4Ti_5O_{12}$ (LTO) composite negative electrode, and a $Li_2OHCl_{0.9}F_{0.1}/Li_{0.31}La_{0.56}TiO_3$ composite solid electrolyte, which were fabricated by a pressure-assisted melt infiltration method. Reversible changes in Li, Ni, and Ti intensities at the electrodes were observed during cycling. In this study, we found that the changes in Ni and Ti signal intensities stem from alterations in ionization efficiency, and that the infiltration of the solid-state electrolyte enhances the electrode reaction.

P1-32

Ion Dynamics and Correlation Study in Solid Electrolytes for All-Solid-State Batteries by Molecular Dynamics Simulations

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The Li ionic conductivity of solid electrolytes for all-solid-state Li-ion batteries batteries is largely determined by their ion diffusion mechanism and the degree of correlation of charge carrier ions. Here, using molecular dynamics simulations, the ion dynamics and ion-ion correlations in oxide-, oxyhalide-, and oxynitride-type solid electrolytes are investigated. The calculation results provide useful insights for experimentalists when formulating material design strategies to achieve high ionic conductivity in solid electrolytes.

P1-33

Sinterability Improvement of NASICON-type Electrolyte for Solid-state Battery

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Research Center for Energy and Environmental Materials (GREEN), NIMS

For realization of all-solid-state batteries (ASSB), it is essential to densify the electrolyte materials to increase interface area between the materials with sufficient conductance. While high-temperature sintering is necessary to reduce interfacial resistance, undesirable resistive phases may form as the reaction products between electrolyte and electrode materials. The study is devoted to lower the sintering temperature of oxide-based solid-state electrolyte. Focusing on the high sinterability previously observed for the mixture of NASICON-type solid electrolyte and olivine-type positive electrode, the mechanism of the sinterability improvement is studied to provide a guideline for lowering sintering temperature.

P1-34

Anion-Sublattice Engineering of $LiNbOCl_4$ Oxyhalide Solid Electrolytes for Enhanced Li-Ion Transport

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$LiNbOCl_4$ is a promising oxyhalide solid electrolyte with fast Li-ion transport, but chemical substitution can strongly alter its conduction behavior. Here, density functional theory and ab initio molecular dynamics are used to clarify how site-selective fluorination affects $LiNbOCl_4$. Fluorination at O sites enhances transport, increasing the predicted 300 K ionic conductivity from 9.57×10^{-3} S cm^{-1} in pristine $LiNbOCl_4$ to 14.77×10^{-3} and 47.67×10^{-3} S cm^{-1} at 4.2% and 8.3% substitution, respectively, whereas Cl-site fluorination suppresses conduction. The contrasting behavior is linked to changes in migration bottlenecks and framework dynamics, establishing anion-sublattice engineering as a design strategy for oxyhalide electrolytes.

P1-35

Synthesis of Low Melting Point $Li_{2.43}Al_{0.21}BO_3$ Solid Electrolytes with Enhanced Lithium Ionic Conductivity

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Solid oxide electrolytes are often more harmless and atmospherically stable than sulfides, but they are very hard and brittle, requiring high sintering temperatures to form a good interface between the solid oxide electrolyte and electrode materials, which often react with each other at high temperatures to form a high resistance interface. To avoid such undesired side reactions, in this study, we focused on lithium borates with a low melting point, and by adjusting the Al content, we synthesized Li-B-Al-O solid electrolyte with a lithium ion conductivity one order of magnitude higher than previously reported $Li_{2.46}Al_{0.18}BO_3$.

P1-36

Interfacial Stability between $LiNbO_3/Nb_2O_5$-Coated 4 V-Class Cathode $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ and PEO-Based Polymer Electrolyte

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[1] Mie Universitu, [2] Umicore Japan KK

In this study, the time variation of interface resistance between PEO-based SPE and a 4V-class cathode active material, $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ (NMC622), coated with amorphous $LiNbO_3$ and Nb_2O_5 was investigated. An improvement in interface stability was observed as the thickness of the coating layer increased. Notably, no change in interfacial resistance was observed even after 40 hours of holding at 4.2 V at 80°C when film thicknesses were between 300 and 400 nm. This contrasts with liquid electrolyte systems, where the effect is only observed at film thicknesses ranging from several nanometers to tens of nanometers.

P1-37

Effects of Co-substitution in the Lithium-Ion Conductor $LiTa_2PO_8$

Hikari Sano, Rintaro Nishiwaki, Kouga Hagi, Yasuaki Matsuda
Chiba Institute of Technology

$LiTa_2PO_8$ is an oxyphosphate promising with poteintial as a lithium-ion solid electrolyte. This material has been investigated to improve its lithium-ion conductivity and sinterability; however, its narrow solid-solution range has limited practical development. In this study, we introduced a cation–anion cosubstitution strategy. Incorporation of lower-valence anions weakens electrostatic interactions and reduces lattice energy, potentially enhancing sinterability and Li^+ transport. We synthesized $Li_{1+y}(Ta_{2-x-y}Zr_{x+y})(PO_4)_{1-x}(PO_3H)_xO_4$, obtaining a single phase and a solid solution for x = 0–0.05. The Li-ion conductivity at 25 °C increased from 6.5×10^{-5} S cm^{-1} (x = y = 0) to 1.0×10^{-4} S cm^{-1} (x = 0.05, y = 0), demonstrating the effectiveness of cosubstitution for enhancing ionic transport.

P1-38

Design of Transition Metal Doped Lanthanum based Perovskites as Cathode Material for Rechargeable Zinc Air Battery Application

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IIT Gandhinagar

Rechargeable zinc air batteries are an emerging energy technology that can complement or surpass the current lithium-ion battery technology in terms of energy density and viability. In this study, we focused on developing an air electrode cathode material which can function as a bifunctional catalyst for a low overpotential oxygen evolution reaction as well as an oxygen reduction reaction for the metal air battery system. A carbon integrated lanthanum perovskite composite is explored with a solution combustion approach and a chemical reduction method, which reduces the impedance and increases the catalytic activity of the system. An effective reduction of interfacial resistance, the ability of lanthanum oxide to effectively reduce oxygen during discharging and the metal doping providing for a crucial OER reaction during the charging phase, delivered the battery potential close enough to the theoretical voltage of 1.59V. The kinetics associated with the metal doped cathode is analyzed in an aqueous two electrode assembly, and system was observed to have an excellent specific capacity of 750 mAh/g and cyclic stability response for over 2000 cycles.

P1-39

Performance of Ultrathin Lithium Metal Anodes with Li–Mg Alloying in All-Solid-State Batteries

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Thin lithium metal anodes are attractive for increasing the energy density of all-solid-state batteries, but their limited thickness can accelerate interfacial degradation during stripping. Here, 5 μm-thick Li films were evaluated and compared with Li–Mg alloy films prepared by vacuum deposition. The thin Li electrodes exhibited rapid degradation associated with loss of interfacial contact during repeated plating/stripping. In contrast, Li–Mg films maintained a more stable interface and improved cycling performance. Cross-sectional observations suggest that Mg promotes uniform alloying and suppresses contact loss. These results demonstrate that alloying is an effective strategy for stabilizing ultrathin Li-metal anodes in sulfide-based all-solid-state batteries.

P1-40

Material Exploration of Anion Conductors for High-Energy Storage Devices

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Institute of Science Tokyo

Monovalent F^- and H^- have low charge density, weakening interactions with the host lattice and making them attractive carriers for anion-driven batteries with high volumetric energy density. We extended superionic frameworks known from other systems to these anions. For fluorides, perovskite $CsPb_{0.9}K_{0.1}F_{2.9}$ conducts F^- via paddle-wheel-like rotation of the Pb^{2+} $6s^2$ lone pair, while $K_{1-x}Ba_xYb_2F_{7+x}$ showed that polyhedral connectivity dictates migration pathways. The same design gave fast H^- conduction in $AELiH_3$ and Ba_2MgH_6, and an anti-alpha-AgI-type conductor, $Ba_{0.5}Ca_{0.35}Na_{0.15}H_{1.85}$, with 3D diffusion through a bcc cation framework. With it, MgH_2 delivers 2,030 mAh/g reversibly at 90 C.

P1-41

Quantitative Visualization of Reaction Inhomogeneity in Graphite Composite Electrodes for All-Solid-State Batteries

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Reaction inhomogeneity in graphite composite electrodes limits material utilization in all-solid-state batteries. Here, operando confocal microscopy was used to visualize lithiation in electrodes with different graphite volume fractions. Quantitative image analysis evaluated the lithiation stage distribution and through-thickness state of charge (SOC) distribution. Higher graphite volume fraction resulted in a steeper SOC gradient across the electrode thickness with low capacity, which suggests the increased ionic transport limitation. This approach enables quantitative evaluation of composition dependent reaction distributions and provides insight into composite electrode design.

P1-42

Structure-Based Design of Fluoride-Ion Conductors

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Fluoride-ion conductors for all-solid-state batteries require higher room-temperature conductivity. Layered fluorite-type and anti-α-AgI-type structures are selected as promising frameworks. Both were modified by elemental substitution, with mechanisms examined by structural analysis and molecular dynamics simulations. In layered fluorite-type $PbSnF_4$, aliovalent substitution at the Sn site introduced interstitial fluoride ions into the Sn-Sn interlayer, suppressing the phase transition to the poorly conductive phase; $PbSn_{0.96}In_{0.04}F_{4.04}$ reached 9.1 mS cm^{-1} at 298 K. In anti-α-AgI-type $Pb_{0.667}K_{0.333}F_{1.667}$, Rb substitution expanded the lattice and enhanced the ionic conductivity; $Pb_{0.667}K_{0.222}Rb_{0.111}F_{1.667}$ reached 0.26 mS cm^{-1} at 298 K, the highest reported for this structure type.

P1-43

Degradation Behavior of Uncoated Single-Crystal-Like and Polycrystalline NCM523 in All-Solid-State Batteries

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Uncoated single-crystal-like (SC) and polycrystalline (PC) NCM523 electrodes were comparatively examined in sulfide-based all-solid-state cells. By employing electrochemical impedance spectroscopy with a chemically reduced $Li_4Ti_5O_{12}$ reference electrode, four resistive components were separated using three-electrode cells. The charge-transfer resistance and interparticle contact-related resistance increased with cycling in the PC cell, suggesting the main origin of the degradation, while the recovery of the contact-related resistance tracked the capacity change. Both resistive components were kept low in the SC cell, leading to the higher cycling stability. Controlling the particle architecture is therefore an effective approach for improving the cycling stability of sulfide-based all-solid-state batteries.

P1-44

Application of Electrolytic Manganese Dioxide as a Cathode Material for Lithium-Ion Batteries

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This study investigates the use of electrolytic manganese dioxide (EMD), a common cathode active material in primary batteries, as a cathode active material in rechargeable batteries. We prepared several types of EMD with different material properties and evaluated their discharge performance. The results revealed that stacking disorder has the greatest impact on the discharge capacity. It is hypothesized that the stacking disorder increased the dimensionality of Li^+ diffusion, which is typically one-dimensional, and facilitate Li^+ ion insertion. On the other hand, the results of cycle testing on all-solid-state batteries suggested that stacking disorder degrade cycle performance.

P1-45

Low-Dose Nanostructural Mapping of Battery Cathodes by 4D-STEM

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Balancing energy density and stability in battery cathodes requires understanding nanoscale structural changes. Here, we applied cepstrum matching analysis (CMA) to four-dimensional scanning transmission electron microscopy (4D-STEM) data to identify crystal phases. CMA maps nanostructures over hundreds of nanometers at approximately 1 nm resolution, using electron doses orders of magnitude below conventional atomic-resolution imaging. In a cycled epitaxial $LiCoO_2$ thin film, degraded phases were confined within a few nanometers of the interface, while the bulk retained the layered structure. Combined with data science for reliable and fast phase identification, CMA could guide nanoscale design of high-energy cathodes.

P1-46

Ultra-High-Resolution 3D Microstructure Characterization of All-Solid-State Sodium Batteries

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Quantitative three-dimensional characterization of complex electrode microstructures is essential for optimizing all-solid-state batteries. In this study, an ultra-high-resolution FIB-SEM imaging and advanced post-processing workflow was developed for $Na_3V_2(PO_4)_3$ (NVP) -$Na_3Zr_2Si_2PO_{12}$ (NZSP) all-solid-state sodium batteries. Serial-section datasets were acquired at 2.5 and 10 nm in-plane pixel sizes to evaluate the effect of resolution on phase identification and quantification. A patch-based U-Net segmented NVP, NZSP, carbon, and pores, while a CycleGAN was used to generate synthetic training data. The resulting 3D reconstructions were quantitatively analyzed to extract key microstructural parameters, enabling a detailed assessment of nanoscale electrode structures.

P1-47

Co-sintering Reaction Analysis of $LiCoO_2$ Cathodes and NASICON-Type LATP Solid Electrolytes Studied by Experimental and Computational Methods

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Understanding interfacial reactions between cathodes and solid electrolytes is essential for developing oxide-based all-solid-state batteries. In this study, $LiCoO_2$ (LCO) and NASICON-type $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ (LATP) composites were co-sintered at various temperatures and mixing ratios. Reaction products were quantitatively analyzed using complementary XRD and XANES measurements and compared with thermodynamic calculations. While the predicted phases agreed well with experimental observations at high temperatures, significant deviations appeared at lower temperatures due to kinetic constraints. These results demonstrate that combining thermodynamic and kinetic considerations is crucial for predicting interfacial reactions and optimizing co-sintering conditions in all-solid-state batteries.

P1-48

Resolving Hetero-Electrolyte Ion-Transport Resistance: A Four-Electrode Approach

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Achieving high-performance solid-state batteries requires stable operation of fast-ion kinetics at the heterogeneous interfaces. To suppress accelerated degradation at the active-material | solid-electrolyte (SE) interfaces, employing different types of appropriately selected catholytes and anolytes realizes improved stability. However, such bilayer architecture may introduce thermodynamically driven decomposition at the hetero-electrolyte interface, giving rise to a substantial interfacial impedance. In this context, quantifying the evolution of hetero-electrolyte impedance is a critical issue. In this work, we demonstrate the application of the four-point method to selectively resolve the impedance evolution of Li-ion-conducting hetero-electrolyte interfaces. As model systems, thermodynamically stable sulfide–sulfide and unstable halide–sulfide hetero-electrolyte interfaces are selected. We show that interfacial geometry is the dominant bottleneck to Li-ion transport at stable sulfide–sulfide hetero-electrolyte interfaces, whereas a decomposition-derived interphase governs Li-ion transport at unstable halide–sulfide hetero-electrolyte interfaces.

P1-50

Surface Chemistry of Sulfide Solid Electrolytes Synthesized by Liquid-Phase Methods and Its Impact on All-Solid-State Battery Performance

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Sulfide solid electrolytes are promising materials for all-solid-state batteries because of their high ionic conductivity and favorable mechanical properties. Liquid-phase synthesis offers advantages for controlling particle size and surface chemistry, which can influence solid–solid interfacial reactions and battery performance. Here, we investigate the local and surface structures of sulfide solid electrolytes synthesized by liquid-phase methods and their relationship with electrochemical properties. Structural and surface analyses reveal synthesis-dependent differences that cannot be fully described by bulk ionic conductivity alone. These results demonstrate the importance of controlling surface chemistry as well as bulk properties for improving the performance of all-solid-state batteries.

P1-51

Chemically Active LiH_2PO_4 Interphase Precursor Enables Self-Limited Interface Stabilization in Sulfide-Based All-Solid-State Batteries

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Interfacial degradation between layered oxide cathodes and sulfide solid electrolytes severely limits all-solid-state battery commercialization, causing electrolyte decomposition and capacity fading. Herein, we propose low-cost lithium dihydrogen phosphate as a sacrificial interphase precursor to regulate the cathode–electrolyte interface. A continuous 40-nm-thick phosphate layer was deposited onto NCM622 particles. Although increasing initial interfacial resistance, the coated electrode achieved 94.1% capacity retention after 100 cycles, outperforming the bare electrode's 73.9%. Mechanistic analyses revealed that LDP forms a stable phosphate-rich interphase, suppressing sulfur precipitation and elemental interdiffusion. This reactive sacrificial design strategy provides a promising alternative to conventional inert oxide coatings.

P1-52

From Oxygen in the Bulk to Lithium at the Interface: Chemical Potential and Stability in Battery Materials

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Chemical potential plays a fundamental role in determining the thermodynamic stability and electrochemical behavior of battery materials. This work explores chemical potential from two perspectives: oxygen in bulk cathode materials and lithium at solid-state interfaces. First, oxygen chemical potential in layered oxide cathodes is investigated using solid-state electrochemical measurements, providing insights into oxygen stability and degradation mechanisms. Second, inspired by classical potentiometric methods, an AFM-based approach is proposed to spatially resolve lithium chemical potential distributions across solid-state battery interfaces. Together, these approaches aim to establish a deeper understanding of the relationship between local chemical potential, interfacial processes, and battery stability.

Abstract
Poster Presentation

P1. Battery and Cell Materials Fiweld [P1-01~P1-51]
P2. Hydrogen Technology Materials Field [P2-01~P2-24]
P3. Others [P3-01~P3-12]

P2-01

The ultrafine Nb_3Sn superconducting wires and flexible cables

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We are strongly promoting the R&D of ultrafine superconducting wires with a much smaller diameter than human hair. In principle, the bending strain decreases as the wire diameter decreases; therefore, we expect that a brittle compound, such as Nb_3Sn, superconducting wire becomes more flexible through wire diameter reduction. Rutherford cables fabricated with ultrafine Nb_3Sn wires behave as incredibly flexible even after the heat treatment and achieve a large transport critical current at 4.2K. Therefore, these flexible Rutherford cables are very promising for the high-field magnet made by the React & Wind method.

P2-02

Toward Operando Observation of Active Site Dynamics in Oxygen Evolution Catalysts by Lab-Scale Near-Ambient Pressure XPS

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Proton exchange membrane water electrolysis has attracted much attention as a key technology for producing green hydrogen to build a carbon-neutral society. However, its deployment is severely limited by the sluggish kinetics and large overpotential of the anodic oxygen evolution reaction. Therefore, the development of highly active and durable catalysts is urgently needed. Operando analysis is a powerful approach for elucidating the catalytic reaction mechanism. Thus, we aim to implement operando electrochemical XPS by integrating a novel, custom-designed operando cell with a lab-scale NAP-XPS instrument. This will enable us to monitor element-selective behavior during catalysis and clarify its underlying mechanism.

P2-03

Systematic Nanoscale Observation of Rhodium Particles on Strontium Titanate ($Rh/SrTiO_3$) Catalyst via Advanced Scanning Transmission Electron Microscopy

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The Dry Reforming of Methane reaction transforms greenhouse gases (CO_2, CH_4) into syngas, but conventional nickel-based catalysts suffer from severe high-temperature coking. While rhodium-supported strontium titanate ($Rh/SrTiO_3$) offers an anti-coking alternative, requiring atomic-scale understanding of structural changes. $Rh/SrTiO_3$ catalyst was evaluated by advanced STEM. We characterized crystal features, elements electronic structures using HRTEM/STEM, EDS, and EELS at 200kV, respectively. Ex-situ experiment was conducted under CO_2/CH_4 gases at 800 °C for 1.5 hours. Furthermore, in-situ TEM observations were successfully performed at 400, 600, and 800 °C under reactive CO_2/CH_4 environments to monitor real-time microstructural changes and interface phenomena under operational conditions.

P2-04

Catalytic Properties of Hydrogen Ions in Materials

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Hydrogen is abundantly present on Earth in the form of water. Hydrogen incorporated into materials is influenced by factors such as the Fermi level of the host material and the acid-base properties of the occupied sites, exhibiting various charge states and bonding modes, and occasionally serving as active functional sites. In this poster, I present the preferred crystalline sites of hydrogen incorporated into materials and their carbon dioxide reduction capabilities.

P2-05

Surface hydrogen analyzed by low-energy ion beams

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Quantification of hydrogen in the surface atomic layers is needed for under-standing hydrogen-related surface reactions and for their practical applications. However, surface-selective quantification of hydrogen remains a challenge even for advanced analytical techniques. In the present study, we demonstrate the quantification of deuterium in the surface atomic layers of rutile TiO_2(001) by low-energy time-of-flight elastic recoil detection analysis (low-energy TOF-ERDA). The present study further demonstrates that simultaneous TOF and energy analyses (TOF+EA) are useful for separating recoil hydrogen, recoil deuterium, and the large scattering component. Since TOF+EA detects only ions that survive neutralization near the sample surface, TOF+EA-ERDA is extremely surface sensitive.

P2-06

Development of Ortho–Para Hydrogen Conversion Catalysts for Hydrogen Storage

Shusaku Shoji
Research Center for Energy and Environmental Materials (GREEN), NIMS

Efficient ortho–para hydrogen conversion is essential for minimizing boil-off losses during cryogenic hydrogen storage, yet conventional catalysts remain limited in activity at low temperatures. Here, we investigated oxide-based catalysts with controlled structural and electronic features to identify design principles for accelerating spin conversion. Systematic comparison revealed that introducing lattice defects and constructing interfaces between two distinct chemical species markedly enhanced ortho–para conversion rates. These modifications are considered to create local electronic and magnetic environments that promote spin-state conversion without requiring hydrogen dissociation. The results provide a practical strategy for designing high-performance catalysts for efficient hydrogen storage and liquefaction.

P2-07

Enhancement of Hydrogen Evolution Activity for Carbon Nitride Photocatalyst through Defect Engineering

Tetsuya Kako
Research Center for Energy and Environmental Materials (GREEN), NIMS

A carbon nitride photocatalyst is mainly composed of ubiquitous elements such as C and N. Since the photocatalyst does not contain metal, it is a highly lightweight material. Type and amounts of defects of the photocatalyst drastically changed by controlling synthesis conditions such as heating temperature, annealing time, starting materials, and so on. The defects affected some physical properties including hydrogen evolution activity and photophysical properties.

P2-08

Syngas-derived hydrophilic nanocarbons for water purification

Boborahimov Azamat Boborahim Ugli[1,2], Takeshi Fujita[3], Shusaku Shoji[1], Kako Tetsuya*[1], Hideki Abe*[1,2]
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Fibrous hydrophilic nanocarbon (HNC) materials were synthesized via the catalytic reaction of a gas mixture of carbon monoxide (CO) and hydrogen (H_2), i.e., syngas. The synthesized HNC features high specific surface areas and strong adsorption capabilities, rendering it effective for water purification. The HNC surface consists of graphite edge planes functionalized with phenolic hydroxyl groups through interactions with a synthetic byproduct, H_2O vapor. The expanded interlayer spacing of the functionalized edge planes offers an open framework rich in adsorption sites for water-soluble chemical species. Adsorption tests with aqueous dye solutions and actual wastewater demonstrated that HNC outperforms conventional activated carbon, owing to the ability to form strong hydrogen bonds between surface phenolic groups and contaminants.

P2-09

Direct Cobalt–Tantalum Carbide Heterointerfaces via Selective Carburization for Oxygen Evolution Catalysis

Sarah Nadiah Nordin[1,2], Hideki Abe[1,2]
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[2] Saitama University

Transition metal carbides (TMCs) attract widespread attention as noble-metal alternatives due to their unique electronic configurations. Among these, cobalt tantalum carbide Co#TaC represents a highly promising but uncommon ternary carbide with unestablished synthesis pathways. This work presents a unique catalyst architecture utilizing these TMCs to achieve high performance and robust durability. Single-phase CoTaC was successfully synthesized via gas-phase carburization of an exposed Co_2Ta alloy precursor. Transmission electron microscopy (TEM) reveals that this carburization approach yields a highly uniform nano-crystalline framework with strong metal-support interfaces. This nanocomposite, which we term rooted Co#TaC, is such that upon exposure to air, the Co and TaC at the surface oxidize into a catalytically active CoO phase and a corrosion-resistant Ta_2O_5 phase.

P2-10

Magnetic Refrigeration for Hydrogen Liquefaction

Koji Kamiya, Kyohei Natsume, Takashi Hirayama, Tsuyoshi Shirai, Haruumi Yamamoto
Research Center for Energy and Environmental Materials (GREEN), NIMS

Magnetic refrigeration uses the magnetocaloric effect and offers high efficiency. In this study, we developed a high-efficiency hydrogen liquefier and experimentally achieved over 60% of Carnot efficiency.

P2-11

Active Magnetic Regenerative Refrigerator with Rotating Permanent Magnet.

Kyohei Natsume, Uchida Akira, Koji Kamiya
Research Center for Energy and Environmental Materials (GREEN), NIMS

Utilization of liquid hydrogen is essential for mass supply and low cost of hydrogen energy. However, the boil-off gas from storage tanks and transport is a critical issue. The development of highly efficient hydrogen liquefaction equipment is desired. Active Magnetic Regenerative Refrigeration (AMRR), which is one of the magnetic refrigeration methods, has been studied for hydrogen liquefaction to improve the cooling efficiency. We have developed an AMRR system for liquid hydrogen temperature (20 K), using rotating permanent magnets and newly developed magnetic materials.

P2-12

Development of an Effective CuO Hydrogen Permeation Barrier Layer on $ErCo_2$ Magnetic Refrigeration Materials

Ya Xu[3], Keiji Oyoshi[1], Haruka Yoshikawa[2,3], HiroyukiTakeya[3], Hiroshi Amekura[4], Takafumi D. Yamamoto[2], Yoshitaka Matsushita[1], Alexei A. Belik[5], MiyokoTanaka[1], Akiko T. Saito[6], Koji Kamiya[3], Yoshihiko Takeda[3]
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Magnetic refrigeration technology is more energy-efficient for hydrogen liquefaction than conventional gas compression/expansion refrigeration technology. However, exposure of magnetic refrigeration materials such as $ErCo_2$ to a hydrogen atmosphere can result in hydride formation, which compromises the magnetocaloric effect. Therefore, preventing hydrogen from entering magnetic refrigeration materials is crucial. We present a cost-effective and efficient method of enhancing the hydrogen permeation barrier performance of $ErCo_2$ particles. This method involves electroless Cu plating followed by an oxidation treatment to form a CuO layer.

P2-13

Microkinetic Approaches Towards a Predictive Understanding of Electrocatalysis

Hideshi Ooka
Research Center for Energy and Environmental Materials (GREEN), NIMS

Electrocatalysis is critical for clean energy technologies such as water electrolysis and fuel cells. For decades, DFT calculations combined with the Sabatier principle have been the main approach to predict catalytic properties. However, thermodynamic quantities such as binding energies contain no time scale information, making it difficult to predict catalytic rates and lifetimes. To bridge this gap, we need to establish a kinetic framework of catalysis, built not on DFT binding energies but on experimental rate constants. I will present our ongoing efforts toward such a theory, with examples where microkinetic models using experimental rate constants give quantitative, testable predictions of catalyst behavior.

P2-14

Application of EIS to determine reaction rate constants of the electrocatalytic hydrogen evolution/oxidation reaction

Koichi Yatsuzuka, Hideshi Ooka
Research Center for Energy and Environmental Materials (GREEN), NIMS

EIS is a technique that can be used for kinetic analysis of electrocatalysts. EIS data are generally fitted with equivalent circuits, yielding charge transfer resistances commonly compared among catalysts. However, charge transfer resistances are not directly convertible into rate constants. We derived a formula expressing the impedance arising from HER/HOR catalysis using rate constants without equivalent circuit analysis. Simulations show that the impedance is sensitive to the shifts in rate constants, suggesting that rate constants can be obtained by fitting EIS. In this presentation, we will report progress in fitting experimental data and the requirements for this approach.

P2-15

Microkinetic Faradaic Impedance of Hydrogen Evolution and Oxidation Reactions via the Heyrovsky-Volmer-Tafel Mechanism

Sahaya Vijay Jeyaraj, Koichi Yatsuzuka, Hideshi Ooka
Research Center for Energy and Environmental Materials (GREEN), NIMS

Electrochemical impedance spectroscopy (EIS) is widely used to probe electrocatalytic mechanisms, typically by fitting equivalent circuits. However, the charge-transfer resistance from such fits cannot be related to rate constants or binding energies. Here, we overcome this limitation by deriving an analytical Faradaic impedance for these reactions from the rate constants of the Heyrovsky-Volmer-Tafel mechanism. Floquet theory with a Fourier-Bessel expansion solves the nonlinear coverage equation without assuming a small potential amplitude. Consequently, it captures the mean coverage shift at large amplitudes, which linear EIS cannot measure. As a result, fitting measured spectra to this expression returns the rate constant directly.

P2-16

Development of Superconducting Joint Evaluation System

Gen Nishijima, Yasuaki Takeda
Research Center for Energy and Environmental Materials (GREEN), NIMS

We have developed superconducting joining technologies for high temperature superconductors. To evaluate joint resistance and critical current at various temperatures and in magnetic fields, we have developed a superconducting joint evaluation system. The design, operation, and some results are introduced.

P2-17

Superconducting Joint between High-temperature Superconducting Wires

Yasuaki Takeda
Research Center for Energy and Environmental Materials (GREEN), NIMS

Superconducting magnets are widely used for various applications. To improve magnet performance and achieve energy-saving magnet systems, R&D of the high-temperature superconductor (HTS) has progressed. Recently, significant progress on superconducting joint technology for HTS wires has been made to realize magnets operated in persistent current mode. Our motivation is to contribute to facilitating development of full-scale and energy-saving persistent-mode HTS magnets. To achieve this, we have addressed the issues on HTS joint and persistent current through materials research.

P2-18

Crystal structure, thermal stability, and proton conductivity of $RbMg_{1-x}H_{2x}(PO_3)_3 \cdot yH_2O$ with a P_3O_9-ring-based tunnel structure

Miu Aizawa, Yasuaki Matsuda
Chiba Institute of Technology

Mixed-cation phosphates are promising proton conductors over a wide temperature range. We investigated $RbMg_{1-x}H_{2x}(PO_3)_3 \cdot yH_2O$ as a proton conductor with a novel tunnel framework containing water molecules. Despite multistep dehydration, the framework was retained up to 750 °C. The sample with x = 0.15 exhibited proton conductivity above 10^{-2} S cm^{-1} at 75–500 °C, reaching 3.4×10^{-2} S cm^{-1} at 200 °C. These results demonstrate the potential of $RbMg_{1-x}H_{2x}(PO_3)_3 \cdot yH_2O$ as a solid electrolyte for intermediate-temperature fuel cells.

P2-19

Synthesis, Crystal Structure and Proton Conductivity of a Mixed Cation Phosphate, $NaCa_{1-x}Li_xH_x(PO_3)_3 \cdot yH_2O$

Ryoga Kawai, Keita Otsuka, Yasuaki Matsuda
Chiba Institute of Technology

In this study, a novel proton conductor, $NaCa_{1-x}Li_xH_x(PO_3)_3 \cdot yH_2O$, with a tunnel-type framework was synthesized by a coprecipitation method. A single phase was obtained in the range of x = 0 - 0.30, and lattice contraction corresponding to the formation of a solid solution was observed. In this compound, two NaO_6 octahedra, two CaO_8 polyhedra, and PO_4 tetrahedral chains extending along the a-axis are connected to form a rigid framework. Water molecules are present within the tunnels. The proton conductivity increased with increasing x, and the sample with x = 0.30 exhibited a conductivity of 8.53×10^{-3} S / cm at 225 °C.

P2-20

Effect of cerium modification of the oxygen reduction reaction activity of platinum electrode after sulfur-poisoning

Tetsuro Morooka[1], Takuya Nakanishi[2], Takuya Masuda[2]
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The oxygen reduction reaction on a platinum surface is significantly inhibited by the adsorption of sulfur. We demonstrated that modifying the platinum surface with cerium species promotes the electrooxidation of sulfur, making it an effective removal technique. This cerium modification was achieved either by immersing the platinum surface in a cerium-containing aqueous solution while bubbling hydrogen gas through it, or by applying a potential of 0.0 V vs. RHE. On the cerium-modified platinum electrode, sulfur oxidation occurred at a potential shifted 0.5 V in the negative direction, compared to the cerium-free platinum electrode (1.0 V). We compared the oxygen reduction reaction activity of the cerium-modified platinum electrode and the cerium-free platinum electrode after sulfur removal.

P2-21

Proton Transport under Reduced Humidity in Fluorinated Bisphosphonate-Bridged Zirconium(IV) Phosphonates

Jinhui Shi, Wakana Matsuda, Ziyi Yue, Takaya Ogawa*
Department of Socio-Environmental Energy Science, Graduate School of Energy Science, Kyoto University

Proton conductors that remain effective at reduced humidity are desirable for electrochemical devices. We investigate zirconium(IV) difluoromethylene diphosphonate (ZrDFMDP) particles with varied P/Zr ratios to examine how phosphonic acid content and structural order influence transport. The layered ZrDFMDP2.5 composition exhibits 21.5 mS cm^{-1} at 80 °C and 80% relative humidity and retains 9.9 mS cm^{-1} at 20% relative humidity. Structural and electrical characterization suggests that organized layers and proton-donating groups contribute to conductivity across these conditions. This work points to fluorinated zirconium phosphonates as candidates for humidity-tolerant proton conduction.

P2-22

Thermodynamic Stability and Ion-Exchange Kinetics of Barium Titanium Oxyhydride from First Principles

Shibghatullah Muhammady[1], Jun Haruyama[1], Fumitaka Takeiri[2], and Genki Kobayashi[1,3,4]
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Barium titanium oxyhydride ($BaTiO_{3-x}H_x$) exhibits hydride (H^-)/e^- mixed conduction and catalytic activity for NH_3 synthesis, leading to potential electrochemical applications but its synthesis shows the hydrogen solubility limits of $x \leq 0.6$ and $x \leq 1$ for topochemical and mechanochemical reactions, respectively. We studied the origins of solubility limits from thermodynamic and kinetics approaches. Phase-diagram analysis shows that the hydride-rich BTOH is metastable, clarifying the beneficial of the mechanochemical reaction. From the kinetic analysis, the topochemical reaction is rate-limited by oxygen diffusion. Our study resolves the previously identified issues.

P2-23

Operando X-ray Absorption Spectroscopy of Carbonate Nickel Electrocatalysts for Water Electrolysis: Roles of Carbonate Anions and Alkali Metal Cations

Shun Tsunekawa, Yu Age, Masaaki Yoshida
Yamaguchi University

Carbonate-containing nickel catalysts are efficient oxygen evolution reaction (OER) electrocatalysts for water electrolysis. We investigated their working-state structures using operando X-ray absorption fine structure (XAFS) spectroscopy spanning hard, tender, and soft X-ray regions. Operando Ni K-edge XAFS revealed transformation of $Ni(OH)_2$-like species into active γ-NiOOH, while C K-edge measurements showed that carbonate anions adsorb at active potentials and stabilize the oxidized NiOOH structure. Alkali metal cations also strongly affected catalyst oxidation behavior and OER activity, with larger cations promoting ion mobility and catalytic activity. These results reveal coupled metal–anion–cation effects in electrocatalysts.

P2-24

Development and Operando XAFS Analysis of Ni/FeO_x Water Splitting Catalysts Prepared by Electrodeposition of NiO_x on FeO_x Powders

Ryosuke Ono, Shun Tunekawa, Masaaki Yoshida
Yamaguchi University

Ni-Fe catalysts are highly active electrocatalysts for water electrolysis and have been extensively investigated. Most studies focus on Ni-Fe catalysts in which Ni and Fe are mixed at the atomic level, while catalysts with micrometer-scale Ni/Fe interfaces remain less explored. Moreover, the effect of FeO_x structure on the activity of Ni/Fe catalysts is not fully understood. Here, we developed Ni/FeO_x catalysts by depositing NiO_x on several FeO_x powders and investigated their structures by operando XAFS. In this presentation, we report their FeO_x-dependent catalytic activities and key insights into the dynamic active states of Ni and FeO_x revealed by operando analysis.

Abstract
Poster Presentation

P1. Battery and Cell Materials Fiweld [P1-01~P1-51]
P2. Hydrogen Technology Materials Field [P2-01~P2-24]
P3. Others [P3-01~P3-12]

P3-01

Multi-dimensional microstructure control in Nb_3Sn superconductors toward fusion energy

Nobuya Banno
Research Center for Energy and Environmental Materials (GREEN), NIMS

In fusion magnets, the superconductors require high strength performance while maintaining high critical current density characteristics. This study addresses this challenge through comprehensive microstructural control that modifies not only the superconducting layer but also the matrix simultaneously.

P3-02

N-doped Niobium MXenes via Hydrothermal and Annealing Routes for Enhanced Electrochemical Performance

Sanghamitra Das[1], Prasanta Kumar Guha[1], Matsuda Shoichi[2]
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In the present work, N-doped niobium MXenes are synthesized via hydrothermal route as well as annealing method to improve and compare the electrochemical performance for energy storage. The addition of nitrogen improves the movement of charges, increases the number of electrochemically active sites and changes the structure of the electrons. Further annealing enhances the crystallinity and electrical conductivity, whereas hydrothermal processing changes the structure and introduces nitrogen. The prepared materials will be characterized using XRD, SEM, Raman, and electrochemical techniques. The goal of this project is to investigate the structure-property relationship and progress on promising MXene electrodes for high-efficiency supercapacitors.

P3-03

Robust coherent phonon mode at GaP/Si(001) heterointerface

Kunie Ishioka
Research Center for Energy and Environmental Materials (GREEN), NIMS

Lattice-matched GaP layers can be grown on Si(001) substrate via a two-step growth procedure, consisting of low-temperature nucleation followed by high-temperature overgrowth. We examine the influence of the two-step growth process on the ultrafast carrier and phonon dynamics of the GaP/Si interface. A phonon mode localized at the buried GaP/Si(001) interface is successfully detected by resonantly photoexciting an interface electronic state to which the phonon is coupled and by detecting transient reflectivity.

P3-04

Quantitative analysis of in-situ TEM images of defective graphene via persistent-homology-based structural analysis

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Defect control in graphene has attracted significant attention for carrier doping and bandgap engineering. To achieve a multiscale quantitative evaluation of defective graphene, we established an analytical method by applying persistent homology, a mathematical framework, to transmission electron microscopy images. Using this approach, we successfully extracted local structural descriptors of defects introduced by electron-beam irradiation, including the roundness and size (polygon order) of carbon atom polygons. Furthermore, we identified carbon rings surrounding “defect clusters” (aggregates of defective polygons), enabling the quantification of the global connectivity of graphene defects.

P3-05

Preparation of (Li,La)TiO_3 ceramics with high grain boundary Li-ion conductivity and visualization of Li-ion transport pathways by negative oxygen ion irradiation

Isao Sakaguchi
Research Center for Energy and Environmental Materials (GREEN), NIMS

(Li,La)TiO_3 ceramics were synthesized to investigate the relationship between sintering conditions, density, phase formation, and Li-ion conductivity. A sample exhibiting bulk and grain-boundary Li-ion conductivities of 4.4×10^{-4} and 6.1×10^{-4} S/cm, respectively, was obtained. Negative oxygen ions were irradiated onto the surfaces of both the synthesized sample and a commercially available (Li,La)TiO_3 ceramics. Analysis of the irradiated surfaces enabled visualization of Li-ion migration pathways. Distinct migration behaviors corresponding to ionic conductivity were identified, providing insight into Li-ion transport mechanism in (Li,La)TiO_3 ceramics.

P3-06

Particle Shape Governs Conduction Loss in Cryogenic Magnetic Refrigerators

Takashi Hirayama[1], Kyohei Natsume[1], Akiko T. Saito[2], Koji Kamiya[1]
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In active magnetic regenerator refrigerators, magnetocaloric particles are packed with helium gas filling the voids, and heat conducted through this bed from the warm to the cold end degrades cooling performance. We measured the effective thermal conductivity of packed beds of spherical and crushed particles at 8–50 K. The effective thermal conductivity, and hence the conduction loss, differed by a factor of 1.8 depending on particle shape. Particle shape is therefore a key design parameter for refrigerators.

P3-07

Pb-free Perovskite Solar Cells

Dhruba Khadka
Research Center for Energy and Environmental Materials (GREEN), NIMS

Halide perovskite photovoltaics have achieved remarkable power conversion efficiencies, yet commercialization remains hindered by the environmental toxicity and regulatory concerns surrounding lead (Pb). Tin-based perovskites represent the most compelling lead-free alternative, offering ideal bandgaps and high carrier mobilities. However, their practical application is bottlenecked by rapid Sn^{2+} oxidation, severe trap-assisted recombination, and lone-pair-driven octahedral off-centering that degrades charge transport. Introducing binary metal fluoride additives (SrF_2, BaF_2, and YbF_3) into $FASnI_3$ mitigates these issues through a dual-channel mechanism. Fluoride anions passivate tin-vacancy traps to suppress oxidation, while metal cations substitute at Sn sites to stabilize the octahedral framework. This boosts efficiency and stability.

P3-08

Durability test and degradation mechanism of metal halide perovskite solar cells

Masatoshi Yanagida, Habiru Miruza, Yasuhiro Shirai
Research Center for Energy and Environmental Materials (GREEN), NIMS

We have investigated the maximum power point tracking (MPPT) test for perovskite solar cells at various temperature. The degradation mechanism of the perovskite solar cells is discussed in this poster session.

P3-09

Conjugated Self-Assembled Monolayer Functionalized with Methoxy Group as Hole-Selective Material for p-i-n Perovskite Solar Cells

Md. Zobaidul Hossen[1,2], Shamim Ahmmed[1], Md. Ataur Rahman[1,2], Marumoto Kazuhiro[3], Ashraful Islam*[1]
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Inverted perovskite solar cells (PSCs) have achieved popularity in recent years and self-assembled monolayer (SAM) materials as hole transport layer (HTL) help to gain this popularity for efficient hole transport and passivation of interfaces. In this study, triphenylamine-based conjugated SAMs functionalized with carboxylic group and two (C23) and four (C24) methoxy group were synthesized and studied. On both C23 and C24 SAMs, good coverage of the perovskite layer was observed. The integration of methoxy group at para-position was found favorable for the growth. In C23 SAM based PSCs, reduced non-radiative charge recombination help to elevate Voc. Moreover, better interfacial contact and smoother morphology facilitate efficient hole transfer, enhancing charge collection efficiency and supporting a high Jsc. As a result, Pb-based triple cation PSC devices on C23 SAM yields a higher PCE of 19.60% than those of C24 (17.80%). Excessive steric hindrance from over bulky molecule creates a physical barrier resulting in slower hole extraction and a decline in Jsc in C24 SAM based PSCs.

P3-10

Development of Lightweight MgB_2 Conductor

Hiroki Fujii
Research Center for Energy and Environmental Materials (GREEN), NIMS

One of the advantages of MgB_2 superconductor is its lightweight property. Cu is usually used as the sheath material for MgB_2 conductors. However, to fully utilize this advantage, Al is more suitable than Cu. Since the melting point of Al is about 660 degrees and the fabrication must be done below this temperature. Low-temperature sintering of MgB_2 conductors is performed under H_2 atmosphere, and the transport critical current density (Jc) value of Al-sheathed conductor reaches about 50 % of that of Fe-sheathed conductor. This difference between Fe and Al is just due to the lower hardness of Al.

P3-11

Crochet Mesh Reinforcement for Seismic Ceiling Safety: A Preliminary Mechanical Investigation of Gypsum Panel Failure Behavior

Aadya Tripathi
India International School in Japan

Suspended gypsum ceiling panels pose a seismic hazard: their brittleness causes shattering during earthquakes, and industrial design codes carry cost premiums many regions forgo. This research tested whether crocheted cotton yarn mesh embedded in gypsum panels could improve seismic safety by changing failure mode. A three-point bending test was used to compare two crochet architectures against plain gypsum: a compact weave and a spaced-stitch mesh allowing paste interlock. While the plain panels shattered completely, both reinforced panels stayed intact and the open-mesh panels cracked 38% higher than plain gypsum—showing mesh design, not mere presence of reinforcement, determines the strength-safety trade-off.

P3-12

Heterometallic ludwigite $M_{2.5}T_{0.5}(O_2BO_3)$ and $(M_2T)(O_2BO_3)$ (M = Co, Ni, Cu; T = Ti, Sn, Fe) compounds as electrocatalysts

Indrani Govindarasu Shanmugapriya, Srinivasan Natarajan
Indian Institute of Science

Novel ludwigite-type compounds, $M_{2.5}T_{0.5}(O_2BO_3)$ and $(M_2T)(O_2BO_3)$ (M = Co, Ni, Cu; T = Ti, Sn, Fe), were synthesized by conventional solid-state methods and structurally characterized using powder X-ray diffraction and Raman spectroscopy. Their unusual colors were attributed to allowed d–d and metal-to-metal charge-transfer transitions. Magnetic measurements revealed antiferromagnetic behavior in selected Co-, Ni-, Sn-, Ti-, and Fe-containing compounds. All synthesized materials were evaluated as oxygen evolution reaction (OER) electrocatalysts and exhibited promising activity comparable to RuO_2. XPS confirmed elemental compositions and oxidation states, while density functional theory calculations supported the experimental observations, highlighting ludwigite structures as versatile functional materials.

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