TROY TECHNICAL

NEXT-GENERATION ENERGY STORAGE WEEKLY REPORT

October 24 - October 30, 2026 | Issue 2026-W43

Cell-level evidence, manufacturing yield, safety and bankable supply

18	10
ANALYZED ARTICLES	PRIORITY THEMES

Issued 2026-10-30 | English edition | fixed approved cover artwork



Next-Generation Energy Storage: the boundary moved from isolated claims to qualification evidence

18 English articles were reviewed independently from the Japanese edition. Ten themes are retained for management decisions.

SIGNAL 01 | ACTIVE MATERIALS

BESS Failure Rates: Global Decline of 98% from 2018 to 2025

Global lithium-ion battery energy storage system (BESS) failure rates dropped by 98% between 2018 and 2025, according to a report by the Electric Power Research Institute (EPRI).

SIGNAL 02 | CELL DESIGN

CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships

CATL has launched the 9MWh TENER+ and the mass-produced TENER Sodium energy storage systems at All Energy Australia 2026.

SIGNAL 03 | MANUFACTURING

Fiber-type Zinc Battery: KIST's 1-meter flexible power source

Researchers at KIST have developed a fiber-type zinc battery reaching 1 meter in length that retains 89.8% capacity after 10,000 bending cycles.

SIGNAL 04 | SYSTEM VALIDATION

Lithium-Rich Cathodes: Cation Disorder Engineering for 2026

Researchers at Hanbat National University have discovered that intentionally disrupting the atomic structure of lithium-rich cathodes improves capacity and stability.

DECISION

Focus this week's management attention on cell-level evidence, manufacturing yield, safety and bankable supply. Move only when the linked evidence can be reproduced under your own operating conditions.

THREE MANAGEMENT MOVES

1. Buyers: compare technologies under the same duty cycle, safety envelope and total system cost.
2. Suppliers: connect materials claims to electrode processing, yield, validation and secured capacity.
3. Executives: track cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EVIDENCE DISCIPLINE

FACT states what the collected English source reports. BUSINESS READ and ACTION are editorial interpretations. UNKNOWN lists information that the source file does not establish. A linked article is not treated as independent confirmation of every claim.

Five numbers or evidence anchors that require conditions

98%
A16

SOURCE-BOUND CONDITION
Global lithium-ion battery energy storage system (BESS) failure rates dropped by 98% between 2018 and 2025, according to a report by the Electric Power Research Institute (EPRI).

9MW
A17

SOURCE-BOUND CONDITION
CATL has launched the 9MWh TENER+ and the mass-produced TENER Sodium energy storage systems at All Energy Australia 2026.

89.8%
A12

SOURCE-BOUND CONDITION
Researchers at KIST have developed a fiber-type zinc battery reaching 1 meter in length that retains 89.8% capacity after 10,000 bending cycles.

90%
A13

SOURCE-BOUND CONDITION
The disordered rock-salt arrangement prevents transition-metal migration, retaining approximately 90% of initial capacity after 50 cycles.

83%
A05

SOURCE-BOUND CONDITION
Fraunhofer ISE has demonstrated that silicon-rich battery cells can maintain over 83% capacity after 1,000 full cycles when subjected to 1,000 kilopascals of external compression pressure.

HOW TO USE THESE NUMBERS
Each value is shown with the condition stated in the collected English article. Do not compare values across different test methods, device sizes, operating temperatures or commercial stages without normalizing those conditions.

Where the value chain moved

Each stage combines one leading theme and one supporting theme. The report treats handoffs as evidence transfers, not decorative arrows.

1

Active materials

P01/P06

Global lithium-ion battery energy storage system (BESS) failure rates dropped by 98% between 2018 and 2025, according to a.

2

Cell design

P02/P07

CATL has launched the 9MWh TENER+ and the mass-produced TENER Sodium energy storage systems at All Energy Australia 2026.

3

Manufacturing

P03/P08

Researchers at KIST have developed a fiber-type zinc battery reaching 1 meter in length that retains 89.8% capacity after.

4

System validation

P04/P09

Researchers at Hanbat National University have discovered that intentionally disrupting the atomic structure of lithium-rich.

5

Deployment & recycling

P05/P10

Carbon nanotubes (CNTs) achieve electronic percolation in P2-type sodium-ion cathodes at just 1 volume percent, the lowest.

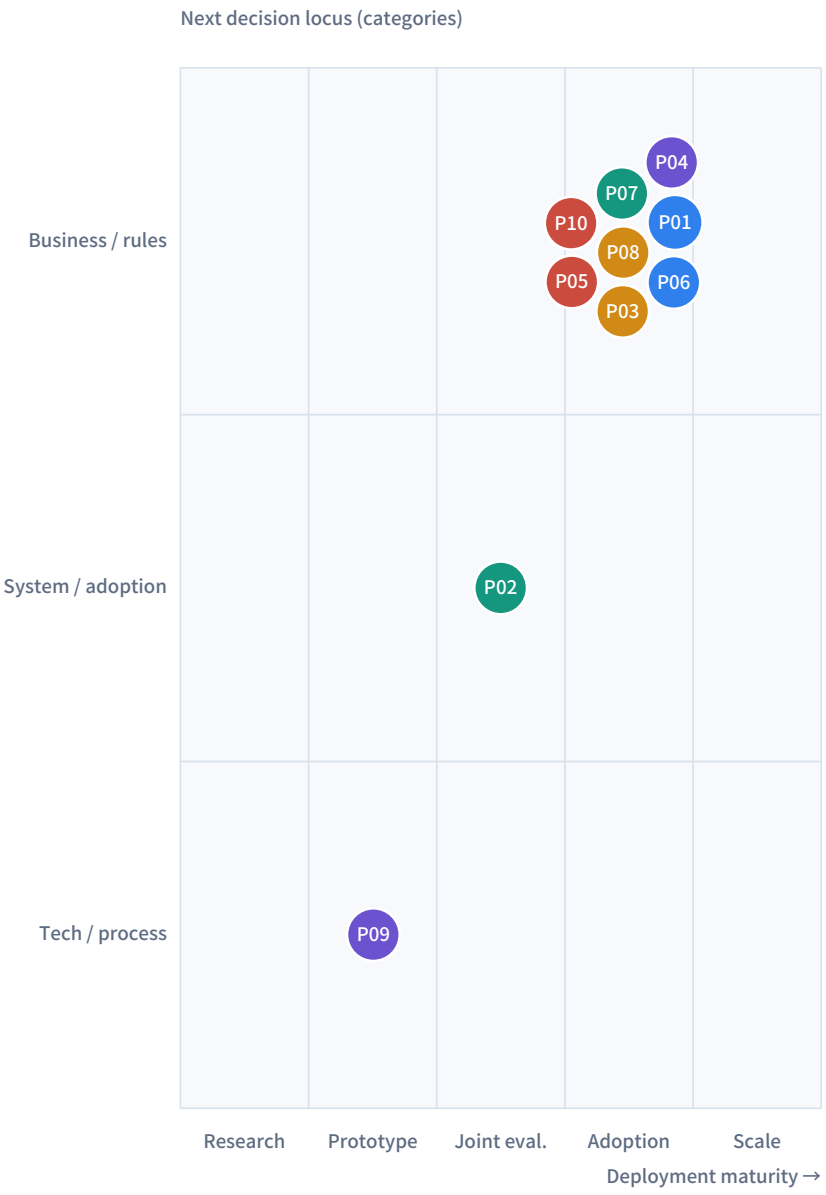
EVIDENCE REQUIRED AT EACH HANDOFF

Active materials to Cell design	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.
Cell design to Manufacturing	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.
Manufacturing to System validation	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.
System validation to Deployment & recycling	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

COMMON CONTROL POINT

No theme moves to a commercial commitment until a named owner has reproduced the relevant evidence and documented cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

Priority map: maturity and next decision locus



P01	BESS Failure Rates: Global Decline of 98% from 2018 to 2025 Business / rules | cue: capacity
P02	CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships System / adoption | cue: Partnerships
P03	Fiber-type Zinc Battery: KIST's 1-meter flexible power source Business / rules | cue: capacity
P04	Lithium-Rich Cathodes: Cation Disorder Engineering for 2026 Business / rules | cue: capacity
P05	Na-ion Cathodes: Carbon Nanotubes vs Acetylene Black Performance Business / rules | cue: capacity
P06	Fraunhofer ISE: Silicon-Rich Battery Cells Cycle Life and Specs Business / rules | cue: capacity
P07	Silicon Anodes: Calendar Aging Mechanisms in NMC811 Cells Business / rules | cue: capacity
P08	HKUST Lithium Metal Batteries: Dynamic Interface Engineering Specs Business / rules | cue: capacity
P09	Anode-Free Lithium Battery: HKUST achieves 467Wh/kg specs Tech / process | cue: no system/business cue
P10	WS2/TiO2@C Anodes: 3D-Printed Heterostructures for Li-ion Storage Business / rules | cue: fid

REPRODUCIBLE POSITIONING RULE

Horizontal position uses five discrete stages: Research, Prototype, Joint evaluation, Product adoption and Scale. The vertical bands classify the next decision locus: Tech / process, System / adoption, or Business / rules (including supply systems). Article-title cues take precedence; the overview is used only when the title is silent. These are categories, not impact ranks. Bubble diameter reflects the editorial score.

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P01 BESS Failure Rates: Global Decline of 98% from 2018 to 2025

A16 | Active materials | Product adoption

Date not stated

FACT

Global lithium-ion battery energy storage system (BESS) failure rates dropped by 98% between 2018 and 2025, according to a report by the Electric Power Research Institute (EPRI). Despite cumulative capacity rising to 634 GWh by 2025, incidents fell to 24, reflecting significant improvements in system design, manufacturing, and safety regulations.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P01.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 21/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

P02 CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships

A17 | Cell design | Joint evaluation

Date not stated

FACT

CATL has launched the 9MWh TENER+ and the mass-produced TENER Sodium energy storage systems at All Energy Australia 2026. The company also signed three MoUs with Hitachi Energy, EPEC Group, and UNSW Sydney to enhance grid integration and workforce training in Australia. These developments address the stability of the National Electricity Market (NEM) as renewable energy generation reaches 44.3%.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P02.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 3/5 | DECISION LOCUS: SYSTEM / ADOPTION

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P03 Fiber-type Zinc Battery: KIST's 1-meter flexible power source

A12 | Manufacturing | Product adoption

Date not stated

FACT

Researchers at KIST have developed a fiber-type zinc battery reaching 1 meter in length that retains 89.8% capacity after 10,000 bending cycles. By suppressing dendrite growth through carbon nanotube modification, the team has created a scalable power source for humanoid robot joints and wearable electronics.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P03.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

P04 Lithium-Rich Cathodes: Cation Disorder Engineering for 2026

A13 | System validation | Product adoption

Date not stated

FACT

Researchers at Hanbat National University have discovered that intentionally disrupting the atomic structure of lithium-rich cathodes improves capacity and stability. The disordered rock-salt arrangement prevents transition-metal migration, retaining approximately 90% of initial capacity after 50 cycles. This approach provides a pathway toward higher energy density batteries for electric vehicles and electronics.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P04.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P05 Na-ion Cathodes: Carbon Nanotubes vs Acetylene Black Performance

A03 | Deployment & recycling | Product adoption

Date not stated

FACT

Carbon nanotubes (CNTs) achieve electronic percolation in P2-type sodium-ion cathodes at just 1 volume percent, the lowest loading among tested additives. However, acetylene black delivers superior discharge capacity (120 mAh/g) and cycling stability despite requiring a higher percolation threshold of 4 volume percent. This indicates that electronic connectivity thresholds alone cannot predict overall electrochemical performance.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P05.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

P06 Fraunhofer ISE: Silicon-Rich Battery Cells Cycle Life and Specs

A05 | Active materials | Product adoption

Date not stated

FACT

Fraunhofer ISE has demonstrated that silicon-rich battery cells can maintain over 83% capacity after 1,000 full cycles when subjected to 1,000 kilopascals of external compression pressure. These cells achieve an energy density of 280 Wh/kg, with potential for 330 Wh/kg in industrially optimized formats. This finding addresses the lifespan limitations that have previously hindered the industrial adoption of silicon-rich anodes.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P06.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P07 Silicon Anodes: Calendar Aging Mechanisms in NMC811 Cells

A07 | Cell design | Product adoption

Date not stated

FACT

Research indicates that calendar aging in lithium-ion cells with silicon anodes is primarily driven by interfacial reactions and the loss of cyclable lithium rather than bulk material degradation. The study identifies the silicon anode as the dominant factor in capacity loss during open-circuit storage, highlighting a critical bottleneck for long-term energy retention.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P07.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

P08 HKUST Lithium Metal Batteries: Dynamic Interface Engineering Specs

A08 | Manufacturing | Product adoption

Date not stated

FACT

Researchers at the Hong Kong University of Science and Technology have developed a dynamic integrated interface engineering strategy for anode-free lithium metal batteries. The approach achieved a specific energy of 467 Wh kg -1 in a pouch cell and 90% capacity retention after 200 cycles in a full coin cell, offering a path toward lighter, longer-lasting batteries.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P08.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P09 Anode-Free Lithium Battery: HKUST achieves 467Wh/kg specs

A18 | System validation | Pilot

Date not stated

FACT

Researchers at the Hong Kong University of Science and Technology (HKUST) have developed an anode-free lithium battery achieving a specific energy of 467Wh/kg. By replacing the conventional graphite anode with a copper foil and a specialized additive, the design reduces weight and volume to increase energy density.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P09.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P10 WS2/TiO2@C Anodes: 3D-Printed Heterostructures for Li-ion Storage

A10 | Deployment & recycling | Product adoption

Date not stated

FACT

Researchers have developed a 3D-printed anode material combining sulfur-vacancy-rich tungsten disulfide (WS2) with a defect-rich titanium dioxide (TiO2) interphase. The 3DP-WTCN anode demonstrated a 200 to 500 percent improvement in areal capacity over pristine WS2, Ti3C2Tx MXene, and unprinted WTCN composites. This approach integrates atomic-scale defect engineering with additive manufacturing to overcome conductivity and structural stability issues in high-capacity anodes.

WHY IT MATTERS

The decision relevance is cell-level evidence, manufacturing yield, safety and bankable supply. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect materials claims to electrode processing, yield, validation and secured capacity.

ACTION

Within 30 days, compare technologies under the same duty cycle, safety envelope and total system cost; record the evidence and owner against P10.

UNKNOWN

Still unproven or incompletely stated: cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

Playbook and 0-5 year roadmap

STAKEHOLDER	NOW | 0-30 DAYS	NEXT | 1-12 MONTHS	LATER | 1-5 YEARS
Operating companies	compare technologies under the same duty cycle, safety envelope and total system cost	Run production-like qualification with explicit acceptance and stop criteria.	Build a portfolio and architecture that can absorb technology and supplier changes.
Materials, equipment and technology suppliers	connect materials claims to electrode processing, yield, validation and secured capacity	Create shared reliability, process-window and failure-analysis data with customers.	Standardize interfaces, traceability, lifecycle support and recovery services.
Trading, investment and legal teams	Map cycle life, fast charge, safety abuse, yield, cost, sourcing and warranty.	Contract for capacity, quality, change notice, liability, alternatives and exit.	Diversify regional, technical and customer concentration risk.

ROADMAP

NOW | 0-30 DAYS
Evidence ledger
Owner: Strategy + quality
Deliverable: claim, source, condition, owner

NOW | 0-30 DAYS
Risk screen
Owner: Procurement + legal
Deliverable: unknowns, alternatives, stop

NEXT | 1-12 MONTHS
Joint qualification
Owner: R&D + supplier
Deliverable: process window and failure data

NEXT | 1-12 MONTHS
Commercial gate
Owner: Business + finance
Deliverable: unit economics and capacity

LATER | 1-5 YEARS
Platform strategy
Owner: Executive team
Deliverable: portfolio and interface roadmap

LATER | 1-5 YEARS
Service layer
Owner: Operations + channel
Deliverable: monitoring, maintenance and recovery

GO / NO-GO GATES

GATE	OWNER	REQUIRED EVIDENCE	NO-GO CONDITION
G1 Evidence	**Quality**	Source, test conditions and reproducibility	No traceable evidence
G2 Integration	**R&D**	Interface, process window and failure analysis	Cannot meet system conditions
G3 Commercial	**Business**	Capacity, total cost, contract and alternatives	Economics or supply cannot be supported
G4 Lifecycle	**Operations**	Monitoring, maintenance, change notice and exit	No accountable operating plan

ANALYZED ARTICLES | ITEMS 01-09

Every title and URL is displayed in full. URLs wrap without shortening and remain clickable. A verified-reference label means the translated HTML did not retain its original source URL.

ID	FULL ARTICLE TITLE	FULL SOURCE / VERIFIED REFERENCE URL - CLICKABLE
A01	PDES Electrolyte: Chonnam University's Sodium Battery Specs	https://www.miragenews.com/chonnam-researchers-develop-safer-durable-1769603/
A02	Sodium-Ion Batteries: Scandium Doping for Extended Cycle Life	https://www.electronicdesign.com/technologies/power/news/55414857/new-research-shows-scandium-doping-can-significantly-boost-sodium-ion-battery-life
A03	Na-ion Cathodes: Carbon Nanotubes vs Acetylene Black Performance	https://bioengineer.org/carbon-nanotubes-lower-percolation-threshold-in-sodium-ion-cathode/
A04	Sodium-Ion Battery Anodes: Iodine-Tuned Hard Carbon Specs	https://bioengineer.org/iodine-tuned-ultramicropores-push-hard-carbon-anodes-forward-in-sodium-ion-batteries/
A05	Fraunhofer ISE: Silicon-Rich Battery Cells Cycle Life and Specs	https://battery-news.de/en/2026/10/26/fraunhofer-ise-tests-silicon-rich-battery-cells-for-over-1000-full-cycles/
A06	SSNC-10 Anode: SnSb-SiOx Composite for -40 °C Li-ion Storage	https://bioengineer.org/snsb-silicon-oxide-anode-sustains-storage-at-temperatures-down-to-%e2%88%9240-c/
A07	Silicon Anodes: Calendar Aging Mechanisms in NMC811 Cells	https://bioengineer.org/silicon-anode-drives-calendar-aging-in-lithium-ion-cells-study-finds/
A08	HKUST Lithium Metal Batteries: Dynamic Interface Engineering Specs	https://www.miragenews.com/hkust-develops-dynamic-interface-for-lithium-1765509/
A09	Anode-Free Batteries: KAIST's Semiconductor-Based Life Extension	https://www.sciencedaily.com/releases/2026/10/261027063708.htm

ANALYZED ARTICLES | ITEMS 10-18

Every title and URL is displayed in full. URLs wrap without shortening and remain clickable. A verified-reference label means the translated HTML did not retain its original source URL.

ID	FULL ARTICLE TITLE	FULL SOURCE / VERIFIED REFERENCE URL - CLICKABLE
A10	WS2/TiO2@C Anodes: 3D-Printed Heterostructures for Li-ion Storage	https://bioengineer.org/defect-rich-tio2-interphase-and-sulfur-vacancies-boost-lithium-storage-in-3d-printed-ws2-anodes/
A11	SUSA Strategy: Fast-Charging Aqueous Zinc Battery Performance	https://bioengineer.org/ultratrace-susa-strategy-boosts-fast-charging-aqueous-zinc-battery-cells/
A12	Fiber-type Zinc Battery: KIST's 1-meter flexible power source	https://biz.heraldcorp.com/article/10918971
A13	Lithium-Rich Cathodes: Cation Disorder Engineering for 2026	https://www.miragenews.com/hanbat-study-finds-cation-disorder-may-improve-1765673/
A14	Lithium Nano-Channels: UT Austin's Selective Extraction Method	https://www.intelligentliving.co/tiny-pores-lithium-extraction-selective/
A15	Sungrow PowerTitan 3.0: Thermal Runaway Containment Test Results	https://www.electropages.com/blog/2026/10/sungrow-powertitan-30-contains-thermal-runaway-large-scale-fire-test
A16	BESS Failure Rates: Global Decline of 98% from 2018 to 2025	https://www.mercomindia.com/global-battery-storage-failure-rate-dropped-98-between-2018-and-2025-report
A17	CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships	https://www.jiji.com/jc/article?k=3KzK6NEk&g=prn
A18	Anode-Free Lithium Battery: HKUST achieves 467Wh/kg specs	https://www.electronicsforu.com/news/anode-free-lithium-battery-reaches-467wh-kg

NextGenEnergyStorage — Selected Articles

Date: 2026-10-31

Articles: 18

Table of Contents

#01 PDES Electrolyte: Chonnam University's Sodium Battery Specs
#02 Sodium-Ion Batteries: Scandium Doping for Extended Cycle Life
#03 Na-ion Cathodes: Carbon Nanotubes vs Acetylene Black Performance
#04 Sodium-Ion Battery Anodes: Iodine-Tuned Hard Carbon Specs
#05 Fraunhofer ISE: Silicon-Rich Battery Cells Cycle Life and Specs
#06 SSNC-10 Anode: SnSb-SiOx Composite for -40 °C Li-ion Storage
#07 Silicon Anodes: Calendar Aging Mechanisms in NMC811 Cells
#08 HKUST Lithium Metal Batteries: Dynamic Interface Engineering Specs
#09 Anode-Free Batteries: KAIST's Semiconductor-Based Life Extension
#10 WS2/TiO2@C Anodes: 3D-Printed Heterostructures for Li-ion Storage
#11 SUSA Strategy: Fast-Charging Aqueous Zinc Battery Performance
#12 Fiber-type Zinc Battery: KIST's 1-meter flexible power source
#13 Lithium-Rich Cathodes: Cation Disorder Engineering for 2026
#14 Lithium Nano-Channels: UT Austin's Selective Extraction Method
#15 Sungrow PowerTitan 3.0: Thermal Runaway Containment Test Results
#16 BESS Failure Rates: Global Decline of 98% from 2018 to 2025
#17 CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships
#18 Anode-Free Lithium Battery: HKUST achieves 467Wh/kg specs

#01 PDES Electrolyte: Chonnam University's Sodium Battery Specs

Published October 30, 2026 Mirage News（全南大学の発表） South Korea

OVERVIEW

Researchers at Chonnam National University have developed a polymerizable deep eutectic solvent (PDES) electrolyte that eliminates leakage and flammability in sodium-metal batteries (SMBs). The electrolyte enables 90.4% capacity retention over 1000 cycles at 2 C, offering a safer, low-cost alternative to lithium-ion systems for grid-level storage.

IN DEPTH

Key Findings

The optimized PDES electrolyte achieved a high ionic conductivity of 1.39 mS cm–1 at 30 °C and a Na-ion transference number of 0.58. In full-cell testing at 0.1 C, the system delivered an initial discharge capacity of 110.2 mAh g-1 with nearly 99% coulombic efficiency. Long-term stability tests showed 90.4% capacity retention over 1000 cycles at a rate of 2 C. Additionally, the electrolyte demonstrated high flame retardance and leakage resistance, maintaining power to an LED in a pouch cell even when the cell was folded and cut.

Technical Details

The PDES electrolyte is composed of sodium perchlorate (NaClO4), N-isopropylacrylamide (NIPAM), and succinonitrile (SN). These components initially form a homogenous liquid deep eutectic solvent (DES) stabilized by hydrogen bonding and ion-dipole interactions. To prevent the leakage common in liquid DES, the team performed in-situ polymerization to create a robust solid matrix.

- **NaClO4:** Serves as the Na-ion source; weak coordination between the perchlorate (ClO4-) anion and Na-ion facilitates salt dissociation.
- **NIPAM:** Promotes Na-ion dissociation via ion-dipole interactions and forms the polymer matrix.
- **SN:** Provides plasticity and further assists in Na-ion dissociation.

This configuration creates a robust electrode-electrolyte interface on the cathode, which suppresses irregular Na growth and parasitic side reactions.

Background & Context

Sodium-metal batteries are viewed as cost-effective alternatives to lithium-ion batteries due to the abundance of sodium reserves. However, practical application has been hindered by the high reactivity of sodium metal, dendrite growth, and the volatility and toxicity of conventional organic liquid electrolytes, which can lead to catastrophic failure at high operating temperatures.

Significance & Outlook

The study, published in Volume 90 of *Energy Storage Materials* on August 01, 2026, suggests that this PDES design enables more sustainable and safer rechargeable batteries. Professor Chan-Jin Park indicates that these advancements could support backup power systems, low-cost battery systems, and renewable energy storage at the grid-level.

Source: https://www.miragenews.com/chonnam-researchers-develop-safer-durable-1769603/

Collected: October 31, 2026 | Automated Research System (AI)

#02 Sodium-Ion Batteries: Scandium Doping for Extended Cycle Life

Published October 28, 2026　Electronic Design（東京理科大学の研究）　USA

OVERVIEW

Researchers at Tokyo University of Science have demonstrated that scandium doping and coating significantly improve the durability of sodium-ion battery (SIB) cathodes. The modification increased capacity retention after 100 cycles from 18.6% to as high as 75.4%, offering a pathway toward lower-cost, long-life energy storage.

IN DEPTH

Key Findings

Scandium modification of cathodes based on NNMO chemistry dramatically enhances the capacity retention of sodium-ion batteries. In tests involving 100 charge-discharge cycles, capacity retention rose from 18.6% for undoped electrodes to 67.8% with scandium doping and 75.4% with scandium coating. Furthermore, full sodium-ion cells utilizing the scandium-coated cathode retained 91.2% of their initial capacity after 300 cycles.

Technical Details

The research team, led by Professor Shinichi Komaba and Associate Professor Shinichi Kumakura from the Department of Applied Chemistry at Tokyo University of Science, utilized two distinct mechanisms to improve the O3-NaNi1/2Mn1/2O2 electrode:

- **Bulk Doping:** Incorporating scandium (Sc3+) into the cathode to stabilize the battery's bulk crystal structure.
- **Surface Coating:** Applying a scandium coating to suppress surface degradation.

These two strategies act as complementary methods to boost overall battery performance and lifespan.

Background and Context

Sodium-ion batteries are gaining traction as an alternative to lithium-ion (Li-ion) batteries due to the greater abundance of sodium, which potentially reduces the cost per kW/h of capacity. Beyond cost, SIBs may offer advantages in safety and performance in low-temperature environments.

Significance and Outlook

This research provides battery manufacturers with a method to produce longer-lived, lower-cost SIB cells. While still in early stages, SIBs are currently being commercialized for backup power applications and stationary, grid-connected battery energy storage systems (BESSs), where they are most likely to compete with Li-ion technology. Additionally, the technology is expanding into electric vehicles (EVs) and portable electronics. The study was published in the journal *Small* under the title "Scandium doping and coating for improving O3-NaNi1/2Mn1/2O2 electrode in sodium battery."

Source: https://www.electronicdesign.com/technologies/power/news/55414857/new-research-shows-scandium-doping-can-significantly-boost-sodium-ion-battery-life

Collected: October 31, 2026 | Automated Research System (AI)

#03 Na-ion Cathodes: Carbon Nanotubes vs Acetylene Black Performance

Published October 25, 2026　Bioengineer.org（Scienmag転載、J. Mater. Sci.）

OVERVIEW

Carbon nanotubes (CNTs) achieve electronic percolation in P2-type sodium-ion cathodes at just 1 volume percent, the lowest loading among tested additives. However, acetylene black delivers superior discharge capacity (120 mAh/g) and cycling stability despite requiring a higher percolation threshold of 4 volume percent. This indicates that electronic connectivity thresholds alone cannot predict overall electrochemical performance.

IN DEPTH

Key Findings

Research on P2-type layered sodium-ion battery cathodes reveals a divergence between electronic percolation thresholds and electrochemical performance. Carbon nanotubes (CNTs) demonstrated the highest efficiency in establishing a conductive network, reaching the percolation threshold at 1 volume percent. In contrast, acetylene black required the highest loading of 4 volume percent to surpass its threshold. Despite this, acetylene black yielded the best electrochemical results, including the highest discharge capacity of 120 mAh/g and a Coulombic efficiency of 83%.

Technical Details

The study experimentally measured percolation thresholds using the positive-electrode active material $Na_{0.68}Mn_{0.45}Co_{0.55}O_2$. The researchers compared several carbon additives, specifically:

- Carbon nanotubes: 1 volume percent percolation threshold.
- Acetylene black: 4 volume percent percolation threshold.
- Super P and Vulcan XC-72: Tested, though numerical thresholds for these materials were not reported in the study abstract.

While CNTs minimized the amount of inactive conductive material needed for connectivity, acetylene black provided superior cycling stability and capacity.

Background & Context

Electronic percolation is a fundamental requirement for electrode composition, ensuring a connected conductive phase. This study focuses specifically on laboratory electrode composites based on one P2-type sodium-manganese-cobalt oxide. The results highlight that while percolation measurements provide a quantitative metric for the minimum carbon required for connectivity, they do not serve as a complete predictor of a battery's final discharge capacity or stability.

Significance & Outlook

The findings suggest that optimizing sodium-ion cathodes requires evaluating electrical connectivity and electrochemical performance as related but distinct properties. The authors conclude that researchers must examine overall electrode composition and formation methods rather than judging conductive additives solely by their percolation thresholds. This provides a quantitative foundation for comparing additives in P2-type layered oxide cathodes, though the behavior may vary in other active materials or commercial cell designs.

Source: https://bioengineer.org/carbon-nanotubes-lower-percolation-threshold-in-sodium-ion-cathode/

Collected: October 31, 2026 | Automated Research System (AI)

#04 Sodium-Ion Battery Anodes: Iodine-Tuned Hard Carbon Specs

Published October 25, 2026　Bioengineer.org（Scienmag転載、Nano-Micro Letters）

OVERVIEW

Researchers have developed an iodine-mediated oxidative cross-linking strategy for starch-based hard carbon anodes to overcome traditional performance trade-offs in sodium-ion batteries. The resulting material achieves a reversible capacity of 352.9 mAh/g and 95.6% capacity retention after 200 cycles by utilizing ultramicropores to regulate electrolyte solvation.

IN DEPTH

Key Findings

The iodine-tuned hard carbon anode delivers a reversible capacity of 352.9 mAh/g at 0.1C and maintains a capacity of 288.9 mAh/g at a 5C rate. The material exhibits an initial Coulombic efficiency of 88.4%, with a plateau contribution accounting for 64.1% of the total discharge capacity. Long-term stability is demonstrated by a 95.6% capacity retention after 200 cycles at 0.33C.

Technical Details

The synthesis utilizes starch as a precursor, modified via iodine-mediated oxidative cross-linking. This process converts the starch framework into a thermally stable conjugated network, suppressing the formation of volatile levoglucosan during pyrolysis. Consequently, the carbon yield increases to 45.5%, compared to less than 10% in iodine-free samples.

The resulting spherical hard carbon is characterized by:

- Abundant ultramicropores smaller than 0.9 nanometers (concentrated between 0.5 and 0.6 nanometers).
- A low external surface area of 1.5 square meters per gram.
- Carbonyl-rich surfaces that provide additional sodium-storage sites.

Density functional theory calculations indicate that pores below 0.804 nanometers act as molecular sieves, sterically excluding bulky ethylene carbonate solvent molecules while allowing sodium ions to enter. This environment promotes the adsorption of PF6 anions and the formation of a NaF-rich inorganic solid electrolyte interphase (SEI), which reduces the interfacial energy barrier for sodium-ion transport.

Background & Context

Sodium-ion batteries are a sustainable alternative to lithium-ion technology, but the larger size of sodium ions makes efficient shuttling through carbon frameworks difficult. While hard carbon is a promising anode material, researchers typically face trade-offs between initial Coulombic efficiency, plateau capacity, charge-transfer kinetics, and cycling stability.

Significance & Outlook

By regulating the electrolyte at the molecular level through ultramicropore confinement, this strategy breaks the conventional performance trade-offs. The ability to preserve the precursor's spherical geometry and deliberately control the pore architecture allows for the creation of an inorganic-rich interphase, significantly improving the electrochemical behavior of sodium-ion anodes.

Source: https://bioengineer.org/iodine-tuned-ultramicropores-push-hard-carbon-anodes-forward-in-sodium-ion-batteries/

Collected: October 31, 2026 | Automated Research System (AI)

#05 Fraunhofer ISE: Silicon-Rich Battery Cells Cycle Life and Specs

Published October 26, 2026 Battery-News（Fraunhofer ISE発表の報道） Germany

OVERVIEW

Fraunhofer ISE has demonstrated that silicon-rich battery cells can maintain over 83% capacity after 1,000 full cycles when subjected to 1,000 kilopascals of external compression pressure. These cells achieve an energy density of 280 Wh/kg, with potential for 330 Wh/kg in industrially optimized formats. This finding addresses the lifespan limitations that have previously hindered the industrial adoption of silicon-rich anodes.

IN DEPTH

Key Findings

Fraunhofer ISE has successfully tested in-house manufactured battery cells featuring silicon-rich anodes for more than 1,000 full cycles. The cells retained over 83% of their original capacity, provided an external compression pressure of 1,000 kilopascals was applied. In contrast, cells tested under a lower pressure of 300 kilopascals showed a more sharp decline in usable capacity.

Technical Details

The research was conducted as part of the StrOboBatt project. The tested pouch cells consist of 40 layers with a capacity of 25 amp-hours and were produced on a semiautomated line. The technical specifications include:

- **Anode:** A silicon-carbon/graphite composite, where the silicon-carbon composite accounts for 51% of the active material.
- **Cathode:** Nickel-rich nickel-manganese-cobalt oxide.
- **Energy Density:** 280 watt-hours per kilogram for the research cells, with an expected 330 watt-hours per kilogram for industrially optimized formats.
- **Testing Parameters:** Charge and discharge cycles were performed in one hour each.

Researchers noted that external pressure is a critical factor as it improves electrical contact and reduces the separation of electrode materials. Additionally, a widening gap was observed between capacity measured at a low discharge rate and capacity available during regular operation as cycle counts increased.

Background and Context

Silicon-rich anodes are highly attractive for applications in electric mobility, aerospace, and stationary energy storage due to their promise of higher energy densities compared to standard lithium-ion batteries. However, limited lifespan has historically been the primary barrier to industrial adoption.

Significance and Outlook

These results indicate that mechanical compression is a key lever in extending the cycle life of high-energy cells. Because performance varies based on discharge rates and pressure, Fraunhofer ISE emphasizes that future applications require a detailed assessment of performance under specific operating conditions. The cells developed serve as a reference for further investigation into new materials and cell designs.

Source: https://battery-news.de/en/2026/10/26/fraunhofer-ise-tests-silicon-rich-battery-cells-for-over-1000-full-cycles/

Collected: October 31, 2026 | Automated Research System (AI)

#06 SSNC-10 Anode: SnSb-SiOx Composite for -40 °C Li-ion Storage

Published October 26, 2026　Bioengineer.org（Scienmag転載、J. Mater. Sci.）

OVERVIEW

Researchers have developed a composite anode, SSNC-10, combining silicon oxide, carbon, and a tin-antimony alloy that maintains lithium storage capabilities at temperatures as low as −40 °C. The material retained approximately 1,000 mAh g−1 after 500 cycles, offering a potential solution for high-capacity batteries in extreme cold environments.

IN DEPTH

Key Findings

The optimized composite anode, designated SSNC-10, demonstrated high cycling stability and low-temperature adaptability in electrode-level tests. It maintained a reversible capacity of approximately 1,000 mAh g−1 after 500 charge-discharge cycles at a current density of 0.5 A g−1. In cold-environment testing, the electrode remained electrochemically active, delivering a stable reversible capacity of 450 mAh g−1 after 100 cycles at −20 °C, 300 mAh g−1 at −30 °C, and 190 mAh g−1 at −40 °C.

Technical Details

The material is a hierarchical SiOx/C-SnSb@NC composite fabricated through in situ alloying and nitrogen-doped carbon encapsulation. The structural design consists of a homogeneously dispersed SnSb bimetallic-alloy network protected by a carbon layer. This architecture addresses several technical hurdles:

- **Conductivity:** The SnSb network improves electronic conductivity and reduces electrode polarization.
- **Structural Integrity:** The collaborative stepwise lithiation behavior of SiOx and SnSb buffers volume expansion, suppressing interfacial side reactions and structural pulverization.
- **Encapsulation:** Nitrogen-doped carbon encapsulation modifies the electrical and structural behavior of the electrode.

Background & Context

Silicon oxide (SiOx) is highly valued for its high theoretical specific capacity but faces practical deployment challenges, including poor electronic conductivity, low initial Coulombic efficiency, and unsatisfactory rate capability. This research, published in the Journal of Materials Science, sought to mitigate these limitations by integrating the SnSb alloy and carbon layers to stabilize the SiOx framework.

Significance & Outlook

The study presents a feasible structural design for silicon-based anodes that require both high capacity and resilience to subzero temperatures. However, the researchers note that this was an electrode-material study rather than a full commercial battery cell demonstration. Consequently, data regarding full-cell energy density, calendar-aging performance, temperature-cycling results, and manufacturing-scale assessment were not provided in the report.

Source: https://bioengineer.org/snsb-silicon-oxide-anode-sustains-storage-at-temperatures-down-to-%e2%88%9240-c/

Collected: October 31, 2026 | Automated Research System (AI)

#07 Silicon Anodes: Calendar Aging Mechanisms in NMC811 Cells

Published October 29, 2026　Bioengineer.org（Scienmag転載、Frontiers in Batteries and Electrochemistry）　USA

OVERVIEW

Research indicates that calendar aging in lithium-ion cells with silicon anodes is primarily driven by interfacial reactions and the loss of cyclable lithium rather than bulk material degradation. The study identifies the silicon anode as the dominant factor in capacity loss during open-circuit storage, highlighting a critical bottleneck for long-term energy retention.

IN DEPTH

Key Findings

A study conducted by researchers from Argonne National Laboratory, the University of Wisconsin-Madison, the National Laboratory of the Rockies, and the University of Chicago Pritzker School of Molecular Engineering reveals that silicon anodes drive calendar aging in lithium-ion batteries. By monitoring three-electrode cells with NMC811 cathodes and milled silicon anodes over 11 months of open-circuit storage, the team determined that degradation is caused by interfacial reactions and the resulting loss of cyclable lithium, not by the extensive loss of active electrode material.

Technical Details

The researchers utilized a combination of capacity measurements, voltage-relaxation analysis, impedance evaluation, and post-test characterization to isolate the contributions of each electrode. The results showed that the silicon anode governed the full cell's discharge impedance and voltage relaxation throughout the aging process. As parasitic reactions consumed the lithium inventory, the operating windows of both electrodes shifted, forcing the NMC811 cathode into higher states of delithiation to compensate for the lithium lost at the silicon interface.

Voltage-relaxation analysis served as a key non-destructive diagnostic tool, identifying two kinetically distinct equilibration processes. The longer-timescale process evolved systematically during each month of storage and partially reset after reference performance test (RPT) cycling, indicating a strong dependence on the silicon electrode's electrochemical history.

Background & Context

Calendar aging occurs due to parasitic side reactions that continue inside a battery even when no current flows. These reactions erode the energy a cell can deliver by consuming cyclable lithium and altering electrode behavior. Post-test characterization confirmed that while the NMC811 and Si electrodes showed only minor capacity loss, there was a significant increase in anode impedance, pointing to the evolution of the solid electrolyte interphase (SEI) and the silicon interfacial environment.

Significance & Outlook

The findings, published in *Frontiers in Batteries and Electrochemistry*, emphasize that the silent chemistry occurring at the silicon interface during storage is the primary factor limiting capacity retention over time for silicon-containing cells.

Source: https://bioengineer.org/silicon-anode-drives-calendar-aging-in-lithium-ion-cells-study-finds/

Collected: October 31, 2026 | Automated Research System (AI)

#08 HKUST Lithium Metal Batteries: Dynamic Interface Engineering Specs

Published October 23, 2026　Mirage News（香港科技大学の発表、Nature Communications）
China

OVERVIEW

Researchers at the Hong Kong University of Science and Technology have developed a dynamic integrated interface engineering strategy for anode-free lithium metal batteries. The approach achieved a specific energy of 467 Wh kg -1 in a pouch cell and 90% capacity retention after 200 cycles in a full coin cell, offering a path toward lighter, longer-lasting batteries.

IN DEPTH

Key Findings

A research team led by Prof. SHAO Minhua at the Hong Kong University of Science and Technology (HKUST) has developed a dynamic integrated interface engineering strategy to enhance the stability and energy density of anode-free lithium metal batteries. A pouch cell utilizing this strategy achieved a specific energy of 467 Wh kg -1, a figure comparable to conventional commercial batteries. Furthermore, a full coin cell demonstrated high stability, retaining 90% of its capacity after 200 cycles.

Technical Details

The team introduced an AMI additive consisting of silver ions paired with anions to address the lithiophobic nature of bare copper (Cu) current collectors. This additive performs multiple synergistic functions:

- **Lithiophilicity:** It improves lithiophilicity to prevent the growth of dendrites.
- **SEI Architecture:** The Ag-modified surface anchors anion-derived species, creating a Solid Electrolyte Interphase (SEI) featuring an organic-rich inner layer (OI) and an inorganic-rich outer layer (IO).
- **Polymerization:** Released anions trigger electrolyte polymerization, forming a quasi-solid OI-IO SEI gel that improves interfacial contact and enables fast lithium-ion transport.

This integrated process allows for highly reversible lithium plating and stripping within a quasi-solid-state configuration.

Background & Context

Lithium metal is a primary candidate for next-generation batteries due to its low reduction potential and high theoretical specific capacity. Anode-free cells, which replace the lithium metal anode with a bare copper current collector, maximize energy density and simplify manufacturing. However, these cells typically suffer from uneven lithium deposition and unstable naturally forming SEIs, which limit battery life and cycling performance.

Significance & Outlook

The research, published in *Nature Communications*, provides a method to modify the current collector and build a robust SEI in a single integrated process. By inhibiting dendrite growth and enhancing stability, this strategy establishes a foundation for the development of safer, lighter, and more durable next-generation battery systems.

Source: https://www.miragenews.com/hkust-develops-dynamic-interface-for-lithium-1765509/

Collected: October 31, 2026 | Automated Research System (AI)

#09 Anode-Free Batteries: KAIST's Semiconductor-Based Life Extension

Published October 28, 2026 ScienceDaily（KAIST） South Korea

OVERVIEW

Researchers at KAIST have developed a method to extend the lifespan of anode-free batteries by applying semiconductor manufacturing techniques to copper foil. By utilizing secondary sputtering lithography and an ultrathin MXene coating, the team reduced lithium dendrite formation to enable smaller, lighter EV batteries with longer ranges.

IN DEPTH

Key Findings

A collaborative team led by Professors Jinwoo Lee and Hee-Tae Jung at KAIST has addressed the limited lifespan of anode-free batteries. By adapting precision fabrication from the semiconductor industry, the researchers created a copper foil structure that ensures more uniform lithium accumulation and promotes a durable protective layer, overcoming the primary barriers to the commercialization of anode-free technology.

Technical Details

The team utilized secondary sputtering lithography (SSL) to create a pattern of microscopic tubes on the copper foil surface. Each tube measures approximately 300 nanometers in width and 150 nanometers in height. This architecture increases the available surface area for lithium deposition to roughly four times that of a standard flat sheet, preventing the concentrated buildup of needle-like dendrites.

Additionally, the researchers applied a 10-nanometer-thick coating of MXene, a two-dimensional material, to the foil. In experiments using a LiPF6-based electrolyte, this coating acts as a foundation that encourages the formation of a stable protective layer rich in lithium fluoride (LiF). This layer restricts the growth of lithium spikes and limits unwanted chemical reactions between the lithium and the electrolyte.

The team verified these results using advanced analytical methods, including:

- X-ray photoelectron spectroscopy (XPS)
- Time-of-flight secondary ion mass spectrometry (ToF-SIMS)
- Transmission electron microscopy (TEM)

Background & Context

Conventional lithium-ion batteries use graphite anodes to store lithium during charging. Anode-free batteries eliminate this material, allowing lithium to accumulate directly on copper foil. While this reduces overall battery weight and thickness—allowing more energy storage in the same space—it typically leads to rapid deterioration due to unstable lithium deposition and the formation of dendrites.

Significance & Outlook

Unlike previous attempts to extend battery life by adding more lithium or thicker coatings—which increased weight and negated the benefits of the anode-free design—this approach maintains the technology's size and weight advantages. This breakthrough provides a pathway toward electric vehicles that can travel farther on a single charge without requiring larger battery packs.

Source: https://www.sciencedaily.com/releases/2026/10/261027063708.htm

Collected: October 31, 2026 | Automated Research System (AI)

#10 WS2/TiO2@C Anodes: 3D-Printed Heterostructures for Li-ion Storage

Published October 29, 2026　Bioengineer.org（Scienmag転載、Advanced Composites and Hybrid Materials）

OVERVIEW

Researchers have developed a 3D-printed anode material combining sulfur-vacancy-rich tungsten disulfide (WS2) with a defect-rich titanium dioxide (TiO2) interphase. The 3DP-WTCN anode demonstrated a 200 to 500 percent improvement in areal capacity over pristine WS2, Ti3C2Tx MXene, and unprinted WTCN composites. This approach integrates atomic-scale defect engineering with additive manufacturing to overcome conductivity and structural stability issues in high-capacity anodes.

IN DEPTH

Key Findings

The 3D-printed anode, designated 3DP-WTCN, achieved significant gains in lithium storage capacity. The WTCN anode delivered a reversible capacity of 697.1 mAh g^{-1} at 0.2 A g^{-1} with 80.2 percent capacity retention, representing improvements of approximately 248 percent over pristine WS2 and 365 percent over Ti3C2Tx MXene. Furthermore, the 3D-printed version provided an additional average increase of approximately 50 percent in specific capacity compared to the non-printed WTCN anode.

Technical Details

The material utilizes a WS2/TiO2@C heterostructure where a carbon-coated composite is integrated into a 3D-printed architecture. The synthesis involves in-situ interphase engineering where Ti3C2Tx MXene partially transforms into a defect-rich TiO2 interphase. This process creates Ti–S-related interfacial interactions that facilitate efficient electron transport and rapid lithium-ion diffusion. To enhance performance, the researchers implemented two primary strategies:

- **Atomic-scale engineering:** Sulfur vacancies in the WS2 provide abundant lithium-ion adsorption sites and accelerate reaction kinetics, while the TiO2 interphase acts as a bridge to create a conductive, mechanically resilient network.
- **Architectural engineering:** 3D printing creates interconnected conductive pathways and shortens ion diffusion distances, allowing the electrode to support high mass loading.

Background & Context

Tungsten disulfide is a promising anode material due to its high theoretical capacity. However, its practical application has been hindered by poor intrinsic electrical conductivity and severe volume changes during repeated charging and discharging cycles. The WS2/TiO2@C design addresses these limitations by using the interphase to mitigate structural degradation during cycling.

Significance & Outlook

The results, published in *Advanced Composites and Hybrid Materials* on 28 October 2026, suggest that combining vacancy and interfacial bonding with additive manufacturing allows anodes to store more lithium while resisting mechanical stress. These findings are based on laboratory-scale electrochemical measurements.

Source: https://bioengineer.org/defect-rich-tio2-interphase-and-sulfur-vacancies-boost-lithium-storage-in-3d-printed-ws2-anodes/

Collected: October 31, 2026 | Automated Research System (AI)

#11 SUSA Strategy: Fast-Charging Aqueous Zinc Battery Performance

Published October 26, 2026　Bioengineer.org（Scienmag転載、Nano-Micro Letters）

OVERVIEW

An ultratrace sulfosuccinic acid (SUSA) additive enables deep, fast charging in aqueous zinc metal batteries by regulating the zinc–electrolyte interface. The strategy achieved an average Coulombic efficiency of 99.48% for over 1,600 cycles in zinc–copper half cells, addressing critical limitations in charging rates and anode stability.

IN DEPTH

Key Findings

The implementation of an ultratrace sulfosuccinic acid (SUSA) strategy significantly enhances the performance of aqueous zinc metal batteries. In zinc–copper half cells, the optimized electrolyte delivered an average Coulombic efficiency of 99.48% for more than 1,600 cycles at 2 mA cm−2 and 1 mAh cm−2. Symmetric zinc cells demonstrated stability for over 1,600 hours at 5 mA cm−2 and 2 mAh cm−2, and more than 675 hours at 10 mA cm−2 and 10 mAh cm−2. Furthermore, a system with a 30 μm zinc electrode reached 3,500 mAh cm−2 of cumulative plated capacity with 56.93% zinc utilization.

Technical Details

SUSA utilizes zincophilic carboxyl groups to preferentially adsorb onto the zinc anode, displacing water and sulfate ions from the inner Helmholtz plane. This creates a water-poor environment that optimizes ion distribution and electric fields. Density functional theory calculations show SUSA binds more strongly to zinc than water on Zn(101) and Zn(002) surfaces, with preferential adsorption on Zn(101) promoting the Zn(002) orientation for more uniform deposition. Electrochemical improvements include:

- Zn^{2+} transference number increase: from 0.26 to 0.41
- Apparent activation energy reduction: from 21.36 to 9.57 kJ mol−1
- Zinc nucleation overpotential reduction: by 23 mV

Background & Context

Conventional aqueous zinc sulfate electrolytes suffer from slow desolvation and charge transfer of strongly hydrated Zn^{2+} ions. Local electric-field variations often lead to nonuniform zinc nucleation, which encourages corrosion, hydrogen evolution, and dendrite growth. While aqueous zinc batteries offer low cost and safety, these interfacial limitations have historically hindered rapid charging and extensive anode utilization.

Significance & Outlook

The strategy was validated in iodine-based full cells, where a cell with a 10 μm zinc electrode (N/P ratio 2.31) completed over 1,490 cycles at 1 A g−1 with 77.13% capacity retention. A pouch cell (N/P ratio 2.04) completed over 680 cycles with 70.17% retention. The system also operated from −20 to 60 °C, including over 300 hours at 60 °C, demonstrating that ultratrace organic additives can simultaneously resolve multiple obstacles regarding current density, cycle life, and temperature range.

Source: https://bioengineer.org/ultratrace-susa-strategy-boosts-fast-charging-aqueous-zinc-battery-cells/

Collected: October 31, 2026 | Automated Research System (AI)

#12 Fiber-type Zinc Battery: KIST's 1-meter flexible power source

Published October 29, 2026 The Herald Business（KISTの発表の報道） South Korea

OVERVIEW

Researchers at KIST have developed a fiber-type zinc battery reaching 1 meter in length that retains 89.8% capacity after 10,000 bending cycles. By suppressing dendrite growth through carbon nanotube modification, the team has created a scalable power source for humanoid robot joints and wearable electronics.

IN DEPTH

Key Findings

The Korea Institute of Science and Technology (KIST) has developed a fiber-type zinc battery capable of continuous production at meter-scale lengths. In durability tests, the battery retained 89.8% of its initial capacity after 10,000 repeated bending cycles. Additionally, full-cell tests demonstrated that the battery retained 85% of its initial capacity after 800 charge-discharge cycles.

Technical Details

To overcome the common issue of dendrite growth—branching crystals on the zinc anode that degrade performance—the research team introduced oxygen functional groups into carbon nanotubes. This modification densely aligns the nanotubes, guiding zinc ions to deposit evenly across the surface and reducing corrosion reactions and hydrogen evolution during cycling.

The team also implemented a continuous electroplating system to enable mass production. This automated process integrates several stages:

- Fiber feeding
- Zinc plating
- Washing
- Drying
- Winding

This system allowed the production of a 1-meter battery, a ten-fold increase over previous fiber-type zinc batteries which were typically limited to 10 centimeters.

Background and Context

Zinc batteries utilize a water-based electrolyte, offering a lower risk of fire or explosion compared to conventional batteries, making them suitable for wearable applications. Unlike prismatic or cylindrical forms, fiber-type batteries can be sewn into fabrics or wrapped around curved surfaces. The project was a collaboration between KIST's Jeonbuk Branch Institute for Advanced Materials, Jeonbuk National University, KAIST, and Kangwon National University.

Significance and Outlook

The researchers verified the technology by integrating the fiber battery with a motion-detection sensor and a flexible solar cell into a combat uniform, allowing for daytime charging and nighttime operation. Future applications include distributed power sources for humanoid robot frames and electronic skin. For full commercialization, the team notes that further improvements are required regarding production speed, plating uniformity over long lengths, and stability during washing and exposure to sweat.

Source: https://biz.heraldcorp.com/article/10918971

Collected: October 31, 2026 | Automated Research System (AI)

#13 Lithium-Rich Cathodes: Cation Disorder Engineering for 2026

Published October 23, 2026　Mirage News（韓国・ハンバット国立大学の発表、Energy Storage Materials）　South Korea

OVERVIEW

Researchers at Hanbat National University have discovered that intentionally disrupting the atomic structure of lithium-rich cathodes improves capacity and stability. The disordered rock-salt arrangement prevents transition-metal migration, retaining approximately 90% of initial capacity after 50 cycles. This approach provides a pathway toward higher energy density batteries for electric vehicles and electronics.

IN DEPTH

Key Findings

A research team led by Professor Kyojin Ku has demonstrated that cation disorder engineering can resolve long-standing performance degradation in lithium-rich cathode materials. The study found that a disordered crystal structure results in more symmetric charge-discharge behavior, higher capacity, and superior performance under high currents compared to ordered counterparts. Notably, the material maintained about 90% of its initial capacity after 50 cycles without a reduction in voltage.

Technical Details

The study focused on a cobalt-free nickel-manganese composition, $Li_{1.2}Ni_{0.4}Mn_{0.4}O_2$. While this material typically forms a layered structure with lithium and transition-metal ions in separate planes, the researchers used high-energy ball milling with two structurally compatible layered starting materials to create a disordered form. This mechanochemical process randomly distributes the cations.

Theoretical and computational analysis revealed that this "disordered rock-salt arrangement" decouples the movement of lithium from that of transition metals. While lithium continues to flow efficiently through a connected network of open pathways, the transition metals are effectively locked in place, preventing them from migrating and blocking lithium ion pathways during cycling.

Background & Context

Lithium-rich cathodes are candidates for next-generation batteries due to their ability to store more charge than current materials. However, they traditionally suffer from irreversible performance loss because transition-metal ions, such as nickel and manganese, drift from their original positions during charging and discharging. Previous scientific efforts focused on preserving an orderly crystal structure to keep pathways clear, whereas this study intentionally disrupts that order.

Significance & Outlook

The findings, published in Volume 90 of *Energy Storage Materials*, suggest that cation disorder can be used as a deliberate engineering tool to overcome barriers affecting high-energy battery materials. Further development of this principle could move lithium-rich cathodes closer to commercial use, potentially increasing the runtime of laptops, phones, and electric vehicles on a single charge.

Source: https://www.miragenews.com/hanbat-study-finds-cation-disorder-may-improve-1765673/

Collected: October 31, 2026 | Automated Research System (AI)

#14 Lithium Nano-Channels: UT Austin's Selective Extraction Method

Published October 30, 2026　Intelligent Living（テキサス大学オースティン校、JACS）　USA

OVERVIEW

Researchers at The University of Texas at Austin have developed artificial nano-channels that are two to five times more selective for lithium than other recently reported artificial transporters. By mimicking biological protein pores, this technology enables precise physical filtering of lithium from brine and recycled batteries while blocking rival ions.

IN DEPTH

Key Findings

Researchers at The University of Texas at Austin have engineered artificial nano-channels that increase lithium extraction selectivity by two to five times compared to other recent artificial transporters. This biological shortcut allows lithium to pass through while excluding sodium, potassium, magnesium, and calcium. The goal is to establish a continuous membrane process that replaces chemical-heavy methods with precise physical filtering.

Technical Details

The channels are constructed using supramolecular chemistry rather than biological proteins. The structure consists of a ring-shaped pillar[5]arene molecule, a symmetrical hoop approximately one nanometer in diameter. To ensure selectivity, the team added chemical handles based on diphenyl phosphine oxide at the entrance.

The selection process relies on the interaction between ions and their hydration shells under an electric field:

- Lithium ions shed their water shells relatively easily, allowing them to enter the channel.
- Magnesium and calcium ions grip their water shells nearly four times more tightly, making the energy cost of stripping them too high for entry.
- Ions that are too large or wrongly coordinated are stalled outside the pore.

Background and Context

Lithium is typically extracted from brine, hard rock, or spent batteries. Conventional evaporation ponds are slow, recovering only 30 to 50 percent of lithium and causing significant water loss; for example, 89 percent of water extraction in the Atacama Salt Flat basin is linked to mining. While direct lithium extraction (DLE) is faster, many DLE methods still require acids, bases, or complex pretreatment. High selectivity is critical because ions like magnesium act as chemical twins to lithium, often ruining purity.

Significance and Outlook

The research provides a "toolkit" for mineral separation. By adjusting the entrance chemistry of the pillar scaffold, the team believes they can design selective channels for other critical minerals such as cobalt and nickel. While current results are based on clean salt mixes, the team notes that further testing in real brines at a larger scale is required.

Source: https://www.intelligentliving.co/tiny-pores-lithium-extraction-selective/

Collected: October 31, 2026 | Automated Research System (AI)

#15 Sungrow PowerTitan 3.0: Thermal Runaway Containment Test Results

Published October 26, 2026 Electropages

OVERVIEW

Sungrow's PowerTitan 3.0 BESS successfully contained thermal runaway in a large-scale fire test without propagation to adjacent containers or a medium-voltage substation. The test, conducted under extreme conditions with disabled suppression systems, confirms the safety of its integrated AC-block architecture.

IN DEPTH

Key Findings

Sungrow has demonstrated that its PowerTitan 3.0 battery energy storage system (BESS) can contain thermal runaway within a single container, preventing fire spread to neighboring units or critical infrastructure. During a large-scale test, the internal temperature of the initiating container peaked at 1,259.8°C over a 7.5-hour period. Despite these temperatures, thermal runaway did not propagate to four adjacent battery containers or the medium-voltage substation, and the initiating container remained structurally intact.

Technical Details

The test configuration simulated a utility-scale installation consisting of 28.56 MWh of fully liquid-cooled PowerTitan 3.0 storage and a 7.4 MW medium-voltage substation. The PowerTitan 3.0 utilizes high-energy-density stacked cells and an integrated AC-block architecture, which houses both the battery system and the DC/AC power converter in a 20-foot container.

To challenge the system's inherent containment capabilities, the following conditions were applied:

- Batteries were charged to 100% state of charge.
- Containers were positioned in a close, back-to-back arrangement.
- All active fire suppression and thermal management systems were disabled.
- Rooftop pressure-relief panels on the initiating container were opened to maximize oxygen availability.

The test was conducted by UL Solutions, witnessed by the Fire Risk Alliance, and observed by Jensen Hughes, adhering to UL 9540A: 2026 and CSA/ANSI C800-2025 standards.

Background and Significance

PowerTitan 3.0 is the first stacked-cell BESS with an integrated AC-block architecture to complete this specific type of test. Sungrow noted that the physical results aligned with previous simulation-based assessments that analyzed hundreds of potential fire scenarios and operating conditions.

This result marks the completion of large-scale fire tests for all three generations of the PowerTitan platform, with each passing on the first attempt. For utility-scale installations, these findings highlight the critical importance of system-level containment to prevent the spread of thermal runaway between containers, thereby reducing the potential scale of damage.

Source: https://www.electropages.com/blog/2026/10/sungrow-powertitan-30-contains-thermal-runaway-large-scale-fire-test

Collected: October 31, 2026 | Automated Research System (AI)

#16 BESS Failure Rates: Global Decline of 98% from 2018 to 2025

Published October 30, 2026 Mercom India India

OVERVIEW

Global lithium-ion battery energy storage system (BESS) failure rates dropped by 98% between 2018 and 2025, according to a report by the Electric Power Research Institute (EPRI). Despite cumulative capacity rising to 634 GWh by 2025, incidents fell to 24, reflecting significant improvements in system design, manufacturing, and safety regulations.

IN DEPTH

Key Findings

The annual failure rate of lithium-ion BESS declined by 98% globally from 2018 to 2025. In 2025, 24 incidents were recorded across 634 GWh of cumulative deployed capacity, compared to 26 incidents across 343 GWh in 2024, representing a 50% year-over-year decrease in the failure rate. Regional reductions were led by China at 99%, followed by the U.S. (97%), South Korea (91%), and Europe (85%). Oceania recorded no failures in 2025.

Technical Details

The EPRI database tracks large-scale thermal events caused by internal faults, such as arc flashes, fires, or explosions, excluding external factors like wildfires. Key technical observations include:

- **Installation Environment:** Indoor systems suffered disproportionately higher damage; the median proportion of damaged capacity was 100% for indoor systems versus 6% for outdoor systems.
- **System Age:** Each additional year of operation was associated with a 31% reduction in failure rates, while each successive installation year saw a 44% reduction.
- **Chemistry:** While LFP and NMC accounted for 96% of deployments by 2022, EPRI found insufficient evidence to establish battery chemistry as an independent risk factor.
- **Comparative Risk:** The average annual container failure rate (0.04% to 0.14%) is comparable to large oil-filled transformers.

Background and Context

Of the 150 total incidents recorded, 33 (22%) were not publicly reported. South Korea had the highest total incidents (55), followed by the U.S. (36), China (25), Europe (20), and Oceania (4). Regarding public safety, 18 incidents involved explosions, resulting in 24 injuries and four fatalities. No acute injuries among the general public were reported, and no fires were found to have spread beyond utility-scale facilities.

Significance and Outlook

EPRI recommends defensive response strategies focusing on thermal monitoring, explosion prevention, and the potential retirement of older systems that fail to meet current safety standards. The findings underscore the importance of evolving regulations, such as the technical standards recently proposed by India's Central Electricity Authority.

Source: https://www.mercomindia.com/global-battery-storage-failure-rate-dropped-98-between-2018-and-2025-report

#17 CATL TENER+ and Sodium: Energy Storage Specs and AU Partnerships

Published October 30, 2026 PR Newswire(時事ドットコム配信) China

OVERVIEW

CATL has launched the 9MWh TENER+ and the mass-produced TENER Sodium energy storage systems at All Energy Australia 2026. The company also signed three MoUs with Hitachi Energy, EPEC Group, and UNSW Sydney to enhance grid integration and workforce training in Australia. These developments address the stability of the National Electricity Market (NEM) as renewable energy generation reaches 44.3%.

IN DEPTH

Key Findings

CATL has introduced two high-capacity energy storage systems, TENER+ and TENER Sodium, designed for the Australian market's extreme weather and grid requirements. To support the deployment of these technologies, CATL entered into three Memoranda of Understanding (MoU) with Hitachi Energy, EPEC Group, and UNSW Sydney. These partnerships focus on integrated power conversion solutions, technical validation for grid compatibility, and the establishment of the Centre for Integrated Renewable Energy Training and Innovation in Western Sydney.

Technical Details

The TENER+ is a 9MWh ultra-large capacity system utilizing liquid cooling. It is designed for a 25-year lifespan and reduces the required number of containers by up to 40% and project footprint by 12%. To prevent the "heat island effect," it employs an upward exhaust system to minimize thermal impact on adjacent PCS units, maintaining rated output during extreme summer conditions. Noise levels are kept below 65dBA at one meter.

The TENER Sodium is a mass-produced sodium-ion battery system with a modular structure providing over 30MWh. It operates at temperatures up to 55°C and achieves over 10,000 cycles at 45°C. The system features a round-trip efficiency of 95% and a lifespan exceeding 20 years.

Background and Context

As of September 2026, renewable energy accounted for 44.3% of generation in the National Electricity Market (NEM). According to the Australian Energy Market Operator (AEMO), grid-scale batteries have begun to outperform gas-fired power in supplying peak nighttime generation, contributing 8% of that load. This shift, combined with the decommissioning of coal plants, increases the demand for energy storage systems with grid-forming capabilities to stabilize voltage and frequency.

Significance and Outlook

By offering both lithium-ion and sodium-ion technologies, CATL provides developers flexibility in supply chain sourcing, as sodium is more geographically abundant than lithium. CATL currently holds a leading global market share, projected to reach 30.4% in 2025 by SNE Research, with over 17GWh of installed capacity in Australia.

Source: https://www.jiji.com/jc/article?k=3KzK6NEk&g=prn

Collected: October 31, 2026 | Automated Research System (AI)

#18 Anode-Free Lithium Battery: HKUST achieves 467Wh/kg specs

Published October 28, 2026 Electronics For You India

OVERVIEW

Researchers at the Hong Kong University of Science and Technology (HKUST) have developed an anode-free lithium battery achieving a specific energy of 467Wh/kg. By replacing the conventional graphite anode with a copper foil and a specialized additive, the design reduces weight and volume to increase energy density.

IN DEPTH

Key Findings

A prototype lithium battery developed by the Hong Kong University of Science and Technology (HKUST) has reached a specific energy of 467Wh/kg. In separate testing, a coin cell utilizing this chemistry retained 90 per cent of its capacity after 200 charge-discharge cycles. These results indicate a significant increase in energy storage per kilogram compared to conventional lithium-ion cells.

Technical Details

The battery eliminates the conventional graphite anode, utilizing bare copper foil instead. During charging, lithium from the cathode plates directly onto the copper. To prevent the formation of dendrites—needle-like spikes that cause internal short circuits—and to stabilize the solid electrolyte interphase (SEI), the team led by Professor Shao Minhua implemented a compound called AMI.

- **AMI Additive:** Combines silver ions with anions to regulate lithium deposition.
- **Mechanism:** Silver encourages even lithium spreading, while anions trigger a reaction that forms a gel within a protective two-layer film.
- **Environment:** This creates a quasi-solid-state environment that blends features of liquid and solid-state battery systems.

Background & Context

Conventional lithium-ion batteries rely on graphite anodes to store lithium. While removing this layer saves space and simplifies manufacturing, it typically leads to uneven lithium deposition and unstable protective films. The HKUST approach aims to mitigate these degradation issues through the AMI additive to make anode-free designs viable.

Significance & Outlook

Higher specific energy could extend the range of electric vehicles and drones or increase the battery life of mobile phones. However, the technology remains at the laboratory stage. Key challenges for commercialization include the cost and availability of the silver-based additive, the difficulty of scaling manufacturing, and the lack of data on how high-energy pouch cells perform over hundreds of cycles under practical conditions. For manufacturers, such as those in India's battery industry, the primary hurdle is determining if the technology can maintain energy density over repeated cycles while remaining affordable.

Source: https://www.electronicsforu.com/news/anode-free-lithium-battery-reaches-467wh-kg

Collected: October 31, 2026 | Automated Research System (AI)