TROY TECHNICAL

PEROVSKITE SOLAR CELLS

WEEKLY REPORT

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

Bankable module performance, durability, manufacturing yield and market entry

15	10
ANALYZED ARTICLES	PRIORITY THEMES

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



Perovskite Solar Cells: the boundary moved from isolated claims to qualification evidence

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

SIGNAL 01 | PRECURSORS

Perovskite Solar Cells: Flexible Modules with 26.9% Efficiency

Researchers from Southeast University and Soochow University have developed flexible perovskite solar cells achieving a peak efficiency of 26.9%.

SIGNAL 02 | CELL STACK

Perovskite Lattice Compliance: Stability Specs for Bifacial Tandems

Researchers have identified "lattice compliance"-the ability of a crystal lattice to elastically accommodate stress-as a key descriptor for the photothermal stability of bifacial perovskite/silicon tandem solar cells.

SIGNAL 03 | MODULE PROCESS

Perovskite Solar Cells: Ambient Blade Coating and 26.1% Efficiency

Researchers have developed a low-hygroscopic solvent system that allows perovskite solar cells to be manufactured via blade coating in ambient air with humidity up to 80%.

SIGNAL 04 | QUALIFICATION

Perovskite Solar Cells: KIER's Li-removal process for stability

Researchers at the Korea Institute of Energy Research (KIER) have developed a catalyst-assisted lithium-removal process that enhances the operational lifespan of perovskite solar cells.

DECISION

Focus this week's management attention on bankable module performance, durability, manufacturing yield and market entry. Move only when the linked evidence can be reproduced under your own operating conditions.

THREE MANAGEMENT MOVES

1. Buyers: compare certified performance with field-relevant lifetime, degradation and warranty evidence.
2. Suppliers: connect precursor and coating control to module yield, encapsulation, lead management and scale.
3. Executives: track stability, area, certification, yield, capex, lead control 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

26.9%
A14

SOURCE-BOUND CONDITION
Researchers from Southeast University and Soochow University have developed flexible perovskite solar cells achieving a peak efficiency of 26.9%.

000 hours
A02

SOURCE-BOUND CONDITION
Devices utilizing this design principle retained 90 percent of initial efficiency after 1,000 hours of ISOS-L-2 testing.

80%
A04

SOURCE-BOUND CONDITION
Researchers have developed a low-hygroscopic solvent system that allows perovskite solar cells to be manufactured via blade coating in ambient air with humidity up to 80%.

25.24%
A01

SOURCE-BOUND CONDITION
The method achieved a power conversion efficiency of 25.24% while maintaining 95% efficiency under accelerated damp-heat testing.

31.13%
A10

SOURCE-BOUND CONDITION
Simulation results indicate that implementing dual serrated microstructures on the front and back surfaces of all-perovskite tandem solar cells can increase power conversion efficiency to approximately 31.13%.

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

Precursors

P01/P06

Researchers from Southeast University and Soochow University have developed flexible perovskite solar cells achieving a peak.

2

Cell stack

P02/P07

Researchers have identified "lattice compliance"-the ability of a crystal lattice to elastically accommodate stress-as a key.

3

Module process

P03/P08

Researchers have developed a low-hygroscopic solvent system that allows perovskite solar cells to be manufactured via blade.

4

Qualification

P04/P09

Researchers at the Korea Institute of Energy Research (KIER) have developed a catalyst-assisted lithium-removal process that.

5

Deployment & recycling

P05/P10

Simulation results indicate that implementing dual serrated microstructures on the front and back surfaces of all-perovskite.

EVIDENCE REQUIRED AT EACH HANDOFF

Precursors to Cell stack	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck stability, area, certification, yield, capex, lead control and warranty.
Cell stack to Module process	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck stability, area, certification, yield, capex, lead control and warranty.
Module process to Qualification	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck stability, area, certification, yield, capex, lead control and warranty.
Qualification to Deployment & recycling	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck stability, area, certification, yield, capex, lead control and warranty.

COMMON CONTROL POINT

No theme moves to a commercial commitment until a named owner has reproduced the relevant evidence and documented stability, area, certification, yield, capex, lead control and warranty.

Priority map: maturity and next decision locus



P01	Perovskite Solar Cells: Flexible Modules with 26.9% Efficiency System / adoption | cue: vehicle
P02	Perovskite Lattice Compliance: Stability Specs for Bifacial Tandems System / adoption | cue: trial
P03	Perovskite Solar Cells: Ambient Blade Coating and 26.1% Efficiency System / adoption | cue: system
P04	Perovskite Solar Cells: KIER's Li-removal process for stability System / adoption | cue: operational
P05	All-Perovskite Tandem Solar Cells: Serrated Surfaces for 31% Efficiency Tech / process | cue: no system/business cue
P06	Perovskite Solar Cells: Gifu University's TiO2 Electron Transport Layer Tech / process | cue: no system/business cue
P07	Perovskite Solar Cells: KIER and UNIST Stability Process 2026 Tech / process | cue: no system/business cue
P08	P3CPenT Derivatives: Computational Design for Perovskite Solar Cells Tech / process | cue: no system/business cue
P09	Lead-Free Perovskite Solar Cells: Sophia University's Stability Fix Tech / process | cue: no system/business cue
P10	Perovskite Solar Cells: Analytical Model for Degradation Losses System / adoption | cue: operational

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 Perovskite Solar Cells: Flexible Modules with 26.9% Efficiency

A14 | Precursors | Pilot

Date not stated

FACT

Researchers from Southeast University and Soochow University have developed flexible perovskite solar cells achieving a peak efficiency of 26.9%. By utilizing a new coating process to maintain high performance in larger modules, the technology enables power generation on curved surfaces like vehicle roofs and backpacks.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P01.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 21/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

P02 Perovskite Lattice Compliance: Stability Specs for Bifacial Tandems

A02 | Cell stack | Joint evaluation

Date not stated

FACT

Researchers have identified "lattice compliance"-the ability of a crystal lattice to elastically accommodate stress-as a key descriptor for the photothermal stability of bifacial perovskite/silicon tandem solar cells. Devices utilizing this design principle retained 90 percent of initial efficiency after 1,000 hours of ISOS-L-2 testing. This framework provides a measurable criterion for screening stable compositions, reducing reliance on trial-and-error testing.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P02.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control 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 Perovskite Solar Cells: Ambient Blade Coating and 26.1% Efficiency

A04 | Module process | Product adoption

Date not stated

FACT

Researchers have developed a low-hygroscopic solvent system that allows perovskite solar cells to be manufactured via blade coating in ambient air with humidity up to 80%. The process achieved a certified power conversion efficiency of 26.1%, potentially removing the need for expensive cleanroom environments in large-scale production.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P03.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: SYSTEM / ADOPTION

P04 Perovskite Solar Cells: KIER's Li-removal process for stability

A01 | Qualification | Pilot

Date not stated

FACT

Researchers at the Korea Institute of Energy Research (KIER) have developed a catalyst-assisted lithium-removal process that enhances the operational lifespan of perovskite solar cells. The method achieved a power conversion efficiency of 25.24% while maintaining 95% efficiency under accelerated damp-heat testing. This breakthrough addresses the volatility of lithium-based additives, paving the way for the commercialization of perovskite tandem cells.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P04.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 20/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

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

P05 All-Perovskite Tandem Solar Cells: Serrated Surfaces for 31% Efficiency

A10 | Deployment & recycling | Research

Date not stated

FACT

Simulation results indicate that implementing dual serrated microstructures on the front and back surfaces of all-perovskite tandem solar cells can increase power conversion efficiency to approximately 31.13%. This design reduces reflection-related photocurrent loss by 18.34%, addressing a primary optical bottleneck in the technology.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P05.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 20/25 | MATURITY 1/5 | DECISION LOCUS: TECH / PROCESS

P06 Perovskite Solar Cells: Gifu University's TiO2 Electron Transport Layer

A11 | Precursors | Product adoption

Date not stated

FACT

Researchers at Gifu University have developed a new electron transport layer using two types of titanium oxide with different microstructures but the same crystal phase. This approach improved power generation efficiency by approximately 10% compared to single-layer titanium oxide and simplifies production processes.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P06.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 19/25 | MATURITY 4/5 | DECISION LOCUS: TECH / PROCESS

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

P07 Perovskite Solar Cells: KIER and UNIST Stability Process 2026

A13 | Cell stack | Pilot

Date not stated

FACT

Researchers from KIER and UNIST have developed a catalytic filtration process that allows perovskite solar cells to retain 95% of their initial efficiency after 1,000 hours of damp-heat testing. By removing degradation-causing components before film formation, the team addressed the trade-off between power conversion efficiency and durability. This method demonstrates a path toward improving the long-term stability of organic semiconductor layers in solar devices.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P07.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P08 P3CPenT Derivatives: Computational Design for Perovskite Solar Cells

A09 | Module process | Research

Date not stated

FACT

Computational modeling of P3CPenT derivatives has identified three new molecules with electronic and optical properties superior to the parent molecule for hole transport. P3CPenT-1 demonstrated a theoretical power conversion efficiency descriptor of 20.80 percent. These findings suggest a path toward reducing reliance on costly, dopant-dependent materials like Spiro-OMeTAD.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P08.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 19/25 | MATURITY 1/5 | DECISION LOCUS: TECH / PROCESS

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

P09 Lead-Free Perovskite Solar Cells: Sophia University's Stability Fix

A15 | Qualification | Pilot

Date not stated

FACT

Researchers at Sophia University have developed a lead-free perovskite solar cell using tin to improve environmental safety and durability. By implementing a layered structure with organic molecules, the team maintained approximately 85% of initial performance after 100 days.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P09.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P10 Perovskite Solar Cells: Analytical Model for Degradation Losses

A08 | Deployment & recycling | Pilot

Date not stated

FACT

Researchers have developed an analytical model that distinguishes between bulk and interfacial degradation in perovskite solar cells, identifying bulk recombination as the primary cause of current density loss. The model demonstrated high accuracy with mean relative errors of 6.4% and 0.8% across two different device architectures. This framework allows developers to prioritize specific material and interface engineering to extend operational lifetimes.

WHY IT MATTERS

The decision relevance is bankable module performance, durability, manufacturing yield and market entry. 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 precursor and coating control to module yield, encapsulation, lead management and scale.

ACTION

Within 30 days, compare certified performance with field-relevant lifetime, degradation and warranty evidence; record the evidence and owner against P10.

UNKNOWN

Still unproven or incompletely stated: stability, area, certification, yield, capex, lead control and warranty.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

Playbook and 0-5 year roadmap

STAKEHOLDER	NOW | 0-30 DAYS	NEXT | 1-12 MONTHS	LATER | 1-5 YEARS
Operating companies	compare certified performance with field-relevant lifetime, degradation and warranty evidence	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 precursor and coating control to module yield, encapsulation, lead management and scale	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 stability, area, certification, yield, capex, lead control 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 01-08

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	Perovskite Solar Cells: KIER's Li-removal process for stability	https://www.pv-magazine.com/2026/10/27/korean-researchers-seek-to-improve-perovskite-solar-cell-stability-with-lithium-removal-process/
A02	Perovskite Lattice Compliance: Stability Specs for Bifacial Tandems	https://bioengineer.org/softer-perovskite-lattices-yield-stable-bifacial-tandem-solar-cells/
A03	Perovskite Solar Cells: AI-Designed Molecule Hits 27.2% Efficiency	https://bioengineer.org/ai-designed-molecule-lifts-perovskite-solar-cells-to-27-2-efficiency-with-lasting-stability/
A04	Perovskite Solar Cells: Ambient Blade Coating and 26.1% Efficiency	https://energiesmedia.com/perovskite-solar-cells-efficiency/
A05	Perovskite Solar Ink: Slow-Curing Epoxy for 21.07% Efficiency	https://www.ecoportal.net/en/chinese-engineers-epoxy-printable-solar/43624/
A06	Perovskite Crystallization: Argonne's Eutectic Method for Optoelectronics	https://finance.yahoo.com/technology/articles/argonne-improves-perovskite-crystal-growth-175200655.html
A07	CsSnI3 Solar Cells: Model-Guided Redesign Hits 10.76% Efficiency	https://bioengineer.org/simulated-and-real-tin-perovskite-solar-cell-hits-10-76-after-model-guided-redesign/
A08	Perovskite Solar Cells: Analytical Model for Degradation Losses	https://www.greenbuildingafrica.co.za/new-model-pinpoints-degradation-losses-in-perovskite-solar-cells/

ANALYZED ARTICLES | ITEMS 09-15

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
A09	P3CPenT Derivatives: Computational Design for Perovskite Solar Cells	https://bioengineer.org/computer-designed-p3cpent-molecules-point-to-better-perovskite-solar-cell-materials/
A10	All-Perovskite Tandem Solar Cells: Serrated Surfaces for 31% Efficiency	https://bioengineer.org/serrated-surfaces-could-push-all-perovskite-tandem-solar-cells-toward-31-percent-efficiency-in-simulations/
A11	Perovskite Solar Cells: Gifu University's TiO2 Electron Transport Layer	https://newswitch.jp/p/50634
A12	Hemispherical Perovskite Solar Cells: Angle-Robust Design Specs	https://www.pv-magazine.com/2026/10/23/hemispherical-perovskite-solar-cell-design-reduces-sensitivity-to-sunlight-angle/
A13	Perovskite Solar Cells: KIER and UNIST Stability Process 2026	https://xenospectrum.com/en/kier-perovskite-solar-cell-catalytic-filtration-damp-heat-stability/
A14	Perovskite Solar Cells: Flexible Modules with 26.9% Efficiency	https://de.nachrichten.yahoo.com/flexible-solarzellen-26-9-prozent-131458373.html
A15	Lead-Free Perovskite Solar Cells: Sophia University's Stability Fix	https://news.solarbe.com/202610/27/50030997.html

PerovskiteSolarCells — Selected Articles

Date: 2026-10-31

Articles: 15

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#01 Perovskite Solar Cells: KIER's Li-removal process for stability

Published October 27, 2026 pv magazine South Korea

OVERVIEW

Researchers at the Korea Institute of Energy Research (KIER) have developed a catalyst-assisted lithium-removal process that enhances the operational lifespan of perovskite solar cells. The method achieved a power conversion efficiency of 25.24% while maintaining 95% efficiency under accelerated damp-heat testing. This breakthrough addresses the volatility of lithium-based additives, paving the way for the commercialization of perovskite tandem cells.

IN DEPTH

Key Findings

The champion device developed by KIER achieved a power conversion efficiency of 25.24%, with a stabilized power output of 25.1% under one-sun illumination. Other performance metrics include an open-circuit voltage of 1.175 V, a short-circuit current density of 25.83 mA/cm², and a fill factor of 83.21%. In terms of stability, the cells retained over 90% of initial efficiency after 500 hours of continuous operation and 95% during accelerated damp-heat testing at 85 C and 85% relative humidity.

Technical Details

The researchers utilized a catalyst-assisted process employing nickel oxide (NiOx) to manage lithium ions within the hole transport layer (HTL). The process works as follows:

- Nickel oxide powder is added to the HTL solution, where it strongly attracts and dissociates lithium ions from lithium salts.
- The NiOx particles, having captured the lithium ions, are subsequently removed from the solution via filtration.
- This allows for the oxidation of the hole transport material spiro-OMeTAD in under five seconds without requiring the conventional additive 4-tert-butylpyridine (tBP).

The resulting HTL showed a 2.5-fold increase in electrical conductivity and produced more uniform films with improved charge extraction. The test cells were constructed using an FTO substrate, a SnO_2 electron transport layer (ETL), a $FAPbI_3$-based perovskite absorber, a spiro-OMeTAD HTL, and a gold (Au) electrode.

Background & Context

Conventional perovskite cells use lithium-based salts to increase electrical conductivity and charge transport. However, these additives are volatile; under high temperatures and humidity, they can evaporate or migrate, creating voids and structural defects. Furthermore, uncontrolled diffusion of released lithium ions into the cell interior typically shortens the device's operational lifespan.

Significance & Outlook

By using a catalyst that is removed after inducing the necessary chemical reactions, KIER has bypassed the stability trade-offs associated with permanent lithium additives. Se Jin Ahn, principal researcher at KIER, stated that this technology marks a milestone for the lifespan of perovskite tandem solar cells. Separately, another KIER team recently achieved a record 26.7% efficiency for a perovskite/CIGS tandem solar cell, as confirmed by the Fraunhofer Institute for Solar Energy Systems.

Source: https://www.pv-magazine.com/2026/10/27/korean-researchers-seek-to-improve-perovskite-solar-cell-stability-with-lithium-removal-process/

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

#02 Perovskite Lattice Compliance: Stability Specs for Bifacial Tandems

Published October 29, 2026 BIOENGINEER.ORG

OVERVIEW

Researchers have identified "lattice compliance"—the ability of a crystal lattice to elastically accommodate stress—as a key descriptor for the photothermal stability of bifacial perovskite/silicon tandem solar cells. Devices utilizing this design principle retained 90 percent of initial efficiency after 1,000 hours of ISOS-L-2 testing. This framework provides a measurable criterion for screening stable compositions, reducing reliance on trial-and-error testing.

IN DEPTH

Key Findings

A study published in Nature Energy on 29 October 2026 demonstrates that higher perovskite lattice compliance enhances the stability of bifacial perovskite/silicon tandem solar cells. Under illumination equivalent to a ground albedo of 0.20, the fabricated monolithic tandem devices achieved a power-generation density of 36.2 milliwatts per square centimetre. In ISOS-L-2 ageing tests, which involve one-sun illumination at 65 degrees Celsius, the cells maintained 90 percent of their initial efficiency for over 1,000 hours of operation.

Technical Details

The research team focused on perovskite absorbers with a bandgap of approximately 1.55 electronvolt. This specific composition reduces the use of bromide, which mitigates light-induced halide segregation and shifts the stability focus toward the intrinsic photothermal resilience of bromide-lean absorbers. The study found that higher lattice compliance improves stability through several mechanisms:

- Suppression of thermally induced microstrain accumulation.
- Shifting of deep-level defects toward shallower states.
- Reduction of disorder in band-edge energetics.

Background & Context

Bifacial tandem solar cells are designed to capture light from both sides to deliver more power per unit area than conventional panels. However, maintaining the stability of the perovskite layer under real operating conditions has been a primary obstacle. The work, led by Fuzong Xu, Jiang Liu, and Xuechun Zhang, along with colleagues including Stefaan De Wolf, establishes lattice compliance as a physically testable framework. This allows researchers to evaluate the mechanical response of the lattice and its link to defect energetics directly.

Significance & Outlook

By providing a measurable criterion for screening materials, this design principle moves the field away from trial-and-error stability testing. While the reported efficiency and stability figures were achieved under controlled laboratory conditions, the authors note that translating the lattice-compliance principle into commercially manufactured bifacial tandem modules will require further validation at scale.

Source: https://bioengineer.org/softer-perovskite-lattices-yield-stable-bifacial-tandem-solar-cells/

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

#03 Perovskite Solar Cells: AI-Designed Molecule Hits 27.2% Efficiency

Published October 28, 2026 BIOENGINEER.ORG

OVERVIEW

Researchers have utilized artificial intelligence to develop a self-assembled monolayer (SAM) molecule, AI-1, that increases perovskite solar cell efficiency to 27.2%. The molecule ensures long-term operational stability, retaining over 95% efficiency after 2,000 hours of testing at 65 °C. This approach demonstrates a systematic method for balancing synthetic accessibility with high-performance interface engineering.

IN DEPTH

Key Findings

The integration of an AI-designed molecule, designated as AI-1, has pushed the power-conversion efficiency of perovskite solar cells to 27.2%. Beyond efficiency, the devices demonstrated significant durability, maintaining more than 95% of their initial efficiency after 2,000 hours of maximum-power-point tracking at 65 °C. This result is particularly meaningful as it represents sustained operation under continuous load at elevated temperatures.

Technical Details

The discovery process employed a pipeline combining a graph neural network for retrosynthetic route prediction, density functional theory (DFT) for high-throughput screening, and expert chemical judgment. From an initial pool of 308 molecular fragments, the system generated over 90,000 candidate structures, which were eventually narrowed down to 300 finalists.

To ensure laboratory viability, the team used a composite score based on eight descriptors. These included:

- Synthesizability
- Hole reorganization energy (λh)
- Heteroatom content
- Aromaticity
- Intrinsic electronic properties

The resulting AI-1 molecule forms robust S–Pb coordination bonds at the buried interface between the monolayer and the perovskite crystal. Mechanistic studies identified a multifunctional methylthio side chain as the critical feature, which reinforces interfacial bonding and balances passivation with chemical robustness to resist the harsh chemistry of the perovskite surface.

Background & Context

Self-assembled monolayers are single-molecule-thick films used to anchor charge extraction in solar devices. A primary challenge in this field is "non-radiative recombination," where excited charge carriers annihilate each other. AI-1 suppresses this wasteful process by strengthening the connection at the interface.

Significance & Outlook

This workflow provides a systematic alternative to traditional discovery by scoring synthesizability and stability alongside electronic performance from the outset. The authors argue that AI-guided design can consistently deliver monolayers that unite high efficiency with long-term operational stability, offering general principles for future interface engineering in photovoltaic technology.

Source: https://bioengineer.org/ai-designed-molecule-lifts-perovskite-solar-cells-to-27-2-efficiency-with-lasting-stability/

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

#04 Perovskite Solar Cells: Ambient Blade Coating and 26.1% Efficiency

Published October 23, 2026 Energies Media USA

OVERVIEW

Researchers have developed a low-hygroscopic solvent system that allows perovskite solar cells to be manufactured via blade coating in ambient air with humidity up to 80%. The process achieved a certified power conversion efficiency of 26.1%, potentially removing the need for expensive cleanroom environments in large-scale production.

IN DEPTH

Key Findings

A research team from the University of Science and Technology of China has demonstrated a certified power conversion efficiency of 26.1% for perovskite solar cells fabricated under ambient air conditions. Notably, the devices maintained this performance even when produced at 80% relative humidity. This result was achieved by blade-coating all three critical layers: the self-assembled monolayers (SAMs), the perovskite absorber, and the passivation layer.

Technical Details

The core innovation is a two-ingredient solvent blend consisting of alcohol and a low-polarity alkane. This "chemical shield" addresses the hygroscopic nature of alcohol-based solvents and the functional materials they carry. While the alcohol dissolves the passivation agents and SAMs, the low-polarity alkane suppresses moisture uptake during the blade-coating process.

Chemical and optoelectronic analyses confirmed that this solvent system prevents two primary failure modes:

- Hydrolysis of organoammonium halide passivation layers.
- Desorption of self-assembled monolayers (SAMs).

The researchers state this is a general approach applicable across multiple hygroscopic materials rather than a fix for a single compound.

Background & Context

While perovskite efficiency rivals silicon, scaling production has traditionally required tightly controlled cleanrooms to protect sensitive layers from moisture. Blade coating is the preferred industrial method due to its compatibility with roll-to-roll manufacturing, but applying moisture-sensitive layers via this method in ambient conditions has previously been difficult to demonstrate successfully.

Significance & Outlook

Eliminating the requirement for humidity-controlled environments significantly shifts the economics of solar manufacturing by lowering infrastructure costs for new market entrants. Because blade coating is compatible with continuous industrial lines, this method offers a viable path to scalable production without sacrificing performance. Future critical tests will focus on long-term stability under real-world conditions and the transition from small research cells to module-scale demonstration.

Source: https://energiesmedia.com/perovskite-solar-cells-efficiency/

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

#05 Perovskite Solar Ink: Slow-Curing Epoxy for 21.07% Efficiency

Published October 25, 2026 The Pulse (Ecoportal) China

OVERVIEW

Chinese engineers have achieved a certified power conversion efficiency of 21.07% on paper-sized perovskite solar panels by integrating a slow-curing epoxy into the printable ink. This method controls polymerization to eliminate pinholes and internal electricity traps, enabling the scaling of high-efficiency cells to larger flexible substrates.

IN DEPTH

Key Findings

Researchers in China have developed a printable perovskite solar ink that reaches a certified efficiency of 21.07% on paper-sized panels. By adding a slow-curing epoxy resin to the precursor liquid solution, the team successfully mitigated the performance drops typically associated with scaling up from small lab-scale spin-coated cells to larger substrates.

Technical Details

The primary technical challenge in solvent-based solar cells is the rapid evaporation of solvents over large surfaces, which often leads to uneven grain formation and the creation of pinholes. To counter this, the engineers utilized a controlled cross-linking agent within the liquid semiconductor ink to regulate polymerization during solvent stripping.

- **Support Matrix:** The low-polymerization-rate epoxy creates a transient support matrix that slows crystallization.
- **Crystal Uniformity:** This control prevents crystals from clumping and ensures the ink is distributed evenly across the substrate.
- **Interface Optimization:** Cross-linking reactions align ion precursors into dense perovskite crystal grains, reducing small voids that typically dissipate electrical charges as heat.
- **Application Method:** The ink was applied to paper-sized substrates using an automated blade-coating system.

Background and Context

While small-scale cells often show excellent efficiency, increasing the scale during manufacturing usually results in drastic performance losses. The use of the epoxy additive allows for stable optoelectronic characteristics across the entire active semiconductor surface area, although slight deviations in thickness on larger surfaces may still prevent the absolute highest efficiencies seen in smaller panels.

Significance and Outlook

The transition to commercial application faces several industrial barriers. While step-growth polymerization works for paper-sized samples, commercial production will require faster roll-to-roll equipment and stricter control of thermal and environmental conditions to prevent edge inconsistencies. Additionally, the cost of special epoxy additives is currently higher than the precursors used in silicon technology. Long-term durability under outdoor conditions and the reduction of polymer synthesis costs remain critical requirements for industrial implementation.

Source: https://www.ecoportal.net/en/chinese-engineers-epoxy-printable-solar/43624/

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

#06 Perovskite Crystallization: Argonne's Eutectic Method for Optoelectronics

Published October 29, 2026 Argonne National Laboratory (Business Wire) USA

OVERVIEW

Argonne National Laboratory has developed a volatile low-melting mechanism using salt additives to reduce defects in perovskite crystal growth. This method enables the production of large, uniform crystalline layers with improved stability and efficiency for next-generation LEDs and solar cells.

IN DEPTH

Key Findings

Researchers at the U.S. Department of Energy's (DOE) Argonne National Laboratory have developed a method to tailor perovskite crystallization at the atomic scale, significantly reducing structural defects. This innovation results in perovskite crystalline layers with more stable performance and higher efficiency, addressing a decade-long bottleneck in the development of reliable optoelectronic devices.

Technical Details

The team utilized a eutectic method, which involves using salt additives to create a mixture that melts at a lower temperature than its individual components. This volatile low-melting mechanism lowers the melting point of the perovskite chemicals providing the atoms for crystal formation, allowing for greater control over how the crystals assemble. Experimental analysis was conducted at the Advanced Photon Source (APS) and the Center for Nanoscale Materials (CNM).

The process produces films with the following characteristics:

- Dramatically fewer atomic defects, reducing charge scattering and energy drain.
- Large-area uniformity and consistency required for manufacturable modules.
- Enhanced optoelectronic performance, specifically in LEDs, resulting in brighter output, higher efficiency, and longer lifetimes.

Background & Context

Perovskites are lab-grown crystals capable of absorbing and emitting light with high efficiency, provided their atomic structure is clean. However, tiny defects typically scatter charge and shorten device lifetimes. The research, published in *Science*, was a collaborative effort involving Argonne and various international institutions and universities.

Significance & Outlook

By enabling the creation of high-quality crystals over large areas, this breakthrough moves perovskite technology closer to real-world manufacturing. The ability to remove major defects allows for the construction of devices that last longer and perform more reliably. Potential applications include the development of brighter screens, more efficient solar panels, and improved sensors for everyday cameras.

Source: https://finance.yahoo.com/technology/articles/argonne-improves-perovskite-crystal-growth-175200655.html

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

#07 CsSnI3 Solar Cells: Model-Guided Redesign Hits 10.76% Efficiency

Published October 26, 2026 BIOENGINEER.ORG

OVERVIEW

Researchers achieved a champion power conversion efficiency of 10.76% for tin-based perovskite solar cells by using the SCAPS-1D simulator to optimize device architecture. This represents an increase from 8.98% in unoptimized devices, demonstrating that numerical modeling can translate into measurable real-world performance gains.

IN DEPTH

Key Findings

A research team has pushed the experimental power conversion efficiency of cesium tin iodide (CsSnI3) solar cells to 10.76%, compared to 8.98% for an unoptimized counterpart. This improvement was achieved by linking computer predictions with laboratory fabrication, systematically optimizing every layer of the n-i-p architecture (FTO/SnO2/CsSnI3/Spiro-OMeTAD/Au) using the SCAPS-1D device simulator.

Technical Details

The simulation, conducted at 300 K under AM 1.5G light, focused on several critical parameters:

- **Absorber Thickness:** The team identified 500 nm as the optimum thickness for CsSnI3. While thicker layers increased photon absorption, gains flattened at 500 nm due to increased transport and recombination losses.
- **Defect Density:** Performance collapsed when defect density rose from 1014 to 1015 cm−3. At 1018 cm−3, efficiency plunged to 3.09% and open-circuit voltage dropped to 0.63 V due to Shockley-Read-Hall recombination.
- **Transport Layers:** In the Spiro-OMeTAD layer, performance saturated at an acceptor density of 1.38 × 1018 cm−3 and remained largely independent of thickness. Conversely, the SnO2 layer was highly thickness-sensitive, with 80 nm identified as the optimum; exceeding this length rapidly degraded efficiency, bottoming out at 14.03% at 400 nm.

The fully optimized simulated device reached a theoretical efficiency of 28.84%, featuring a short-circuit current density of 33.31 mA/cm², an open-circuit voltage of 1.05 V, and a fill factor of 82%.

Background & Context

Tin-based perovskites are attractive as lead-free alternatives, particularly for tandem solar cells, because CsSnI3 has a narrow band gap of roughly 1.31 eV. However, Sn2+ readily oxidizes to Sn4+ when exposed to air, which destabilizes the structure. Since 2012, when efficiencies were approximately 0.9%, researchers have used encapsulation and interface engineering to overcome this fragility.

Significance & Outlook

This work proves that careful parameter selection guided by numerical modeling can yield measurable gains in physical devices, even while the theoretical efficiency ceiling remains distant.

Source: https://bioengineer.org/simulated-and-real-tin-perovskite-solar-cell-hits-10-76-after-model-guided-redesign/

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

#08 Perovskite Solar Cells: Analytical Model for Degradation Losses

Published October 26, 2026 Green Building Africa 南アフリカ

OVERVIEW

Researchers have developed an analytical model that distinguishes between bulk and interfacial degradation in perovskite solar cells, identifying bulk recombination as the primary cause of current density loss. The model demonstrated high accuracy with mean relative errors of 6.4% and 0.8% across two different device architectures. This framework allows developers to prioritize specific material and interface engineering to extend operational lifetimes.

IN DEPTH

Key Findings

The primary driver of current density loss as perovskite solar cells age is bulk recombination. While interfacial recombination also contributes to performance decline, the study found it plays a secondary role compared to losses occurring within the perovskite absorber layer. Additionally, the analysis revealed that degradation is asymmetric, affecting electron and hole related recombination mechanisms differently depending on the device architecture.

Technical Details

The analytical model utilizes steady state carrier continuity equations combined with kinetic degradation laws to track changes in interfacial recombination velocities and bulk carrier lifetimes over time. To validate the model, researchers compared simulated current density against experimental data from two specific architectures:

- FTO, d Ti, m Ti, Spiro OMETAD and Au: The model achieved a mean relative error of 6.4%.
- Mixed halide perovskite FTO, d Ti, m Ti, PTAA and Au: The model achieved a mean relative error of 0.8%.

Background and Context

Perovskite solar cells are considered a promising path toward low-cost solar manufacturing, having achieved power conversion efficiencies exceeding 26% in laboratory settings. However, these cells suffer from instability when exposed to heat and illumination. This performance decline remains a significant technical barrier to large-scale commercial deployment.

Significance and Outlook

By providing a practical framework to separately quantify bulk and interfacial degradation, this model enables researchers and manufacturers to target stability improvements more precisely. Developers can now determine whether performance losses originate in the absorber material or at the layer interfaces, allowing for the prioritization of encapsulation strategies, interface engineering, and material formulation to increase the durability of commercial photovoltaic applications.

Source: https://www.greenbuildingafrica.co.za/new-model-pinpoints-degradation-losses-in-perovskite-solar-cells/

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

#09 P3CPenT Derivatives: Computational Design for Perovskite Solar Cells

Published October 30, 2026 BIOENGINEER.ORG

OVERVIEW

Computational modeling of P3CPenT derivatives has identified three new molecules with electronic and optical properties superior to the parent molecule for hole transport. P3CPenT-1 demonstrated a theoretical power conversion efficiency descriptor of 20.80 percent. These findings suggest a path toward reducing reliance on costly, dopant-dependent materials like Spiro-OMeTAD.

IN DEPTH

Key Findings

A theoretical study published in Discover Electronics indicates that three donor–acceptor derivatives of the P3CPenT molecular framework—P3CPenT-1, P3CPenT-2, and P3CPenT-3—outperform the parent molecule as hole transport materials. P3CPenT-1 emerged as the most promising candidate, with a predicted open-circuit voltage of 1.0965 electron volts, a fill factor of 89.02 percent, and a theoretical power conversion efficiency descriptor of 20.80 percent. P3CPenT-3 followed with a predicted efficiency of 18.05 percent.

Technical Details

Researchers Nida Fatima and Khuram Ali used density functional theory (DFT) and time-dependent DFT (TD-DFT) at the PBEPBE level with the 6-311G(d,p) basis set to model the molecules. Key technical improvements include:

- **Energy Gap:** The HOMO-LUMO gap was reduced from 3.00 electron volts in the reference P3CPenT to between 2.00 and 2.30 electron volts in the derivatives.
- **Optical Absorption:** Maximum absorption wavelengths shifted from the ultraviolet (369.84 nanometers) into the visible range: 551.07 nm (P3CPenT-1), 539.51 nm (P3CPenT-2), and 620.20 nm (P3CPenT-3).
- **Geometry:** Dihedral angles between 179.19 and −179.52 degrees indicate a near-planar geometry, which supports charge delocalization and intermolecular stacking.
- **Energy Alignment:** The derivatives' HOMO levels (−5.3264, −5.1718, and −5.1937 electron volts) align with the valence band maximum of MAPbI3 (approximately −5.4 electron volts).

Background & Context

Perovskite solar cells have reached efficiencies exceeding 26 percent, but the layer transporting positively charged holes from the perovskite to the electrode remains a bottleneck. Current high-efficiency devices rely on Spiro-OMeTAD and PTAA, which are expensive and depend on dopants.

Significance & Outlook

By utilizing a thiophene π-bridge and donor–acceptor architecture, these designed molecules enhance π-electron delocalization and visible light harvesting. The study's use of PyMOlyze 1.1 and Multiwfn confirmed efficient spatial separation of electron–hole pairs, suggesting these theoretical derivatives could provide a more efficient and cost-effective alternative for hole extraction in perovskite cells.

Source: https://bioengineer.org/computer-designed-p3cpent-molecules-point-to-better-perovskite-solar-cell-materials/

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

#10 All-Perovskite Tandem Solar Cells: Serrated Surfaces for 31% Efficiency

Published October 30, 2026 BIOENGINEER.ORG USA

OVERVIEW

Simulation results indicate that implementing dual serrated microstructures on the front and back surfaces of all-perovskite tandem solar cells can increase power conversion efficiency to approximately 31.13%. This design reduces reflection-related photocurrent loss by 18.34%, addressing a primary optical bottleneck in the technology.

IN DEPTH

Key Findings

A simulation study published in *Frontiers of Optoelectronics* demonstrates that replacing flat interfaces with periodic, sawtooth-like serrated microstructures can push the power conversion efficiency of all-perovskite tandem solar cells to approximately 31.13%. This represents a 3.41% increase over the flat baseline. The dual serrated design reduces the photocurrent lost to reflection from 4.47 to 3.65 milliamperes per square centimeter, marking an 18.34% reduction in reflection loss.

Technical Details

The researchers, led by Wenjiang Ye and Aoyue Chen of Huazhong University of Science and Technology, utilized COMSOL Multiphysics to model a device featuring a wide-bandgap perovskite (1.8 electronvolts, 400 nanometers thick) and a narrow-bandgap perovskite (1.25 electronvolts, 1200 nanometers thick). The optimization occurred in two stages:

- **Front Interface:** A periodic serrated texture with a 1 micrometer period and 400 nanometer height was applied. This acted as microscopic lenses, boosting the electric field intensity at the front interface to 100 volts per meter (four times the flat structure) and reducing reflection-loss current density to 3.77 milliamperes per square centimeter.
- **Back Electrode:** Because front textures alone left reflection peaks near 950 nanometers, the team added a similar serrated structure to the back electrode, which can be realized via nanoimprinting the perovskite layer before depositing the metal cathode.

Background & Context

All-perovskite tandem cells stack a wide-bandgap top cell for high-energy photons and a narrow-bandgap bottom cell for redder and near-infrared light. While real devices have reached 30.1% efficiency, the theoretical maximum is near 45%. The gap is primarily due to optical losses; previous analysis indicates optical losses account for roughly 31.15% of total energy loss, with reflection alone contributing up to 19.64%.

Significance & Outlook

By mitigating refractive index mismatch at the interfaces, the serrated design optimizes the balance of photocurrents between the two subcells. This approach targets the specific wavelengths—including 350, 550, 750, and 950 nanometers—where flat devices typically exhibit reflection peaks exceeding 20%.

Source: https://bioengineer.org/serrated-surfaces-could-push-all-perovskite-tandem-solar-cells-toward-31-percent-efficiency-in-simulations/

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

#11 Perovskite Solar Cells: Gifu University's TiO2 Electron Transport Layer

Published October 27, 2026　ニュースイッチ（日刊工業新聞）　Japan

OVERVIEW

Researchers at Gifu University have developed a new electron transport layer using two types of titanium oxide with different microstructures but the same crystal phase. This approach improved power generation efficiency by approximately 10% compared to single-layer titanium oxide and simplifies production processes.

IN DEPTH

Key Findings

A research group led by Associate Professor Kazuhiro Manseki at Gifu University's Faculty of Engineering has developed a novel electron transport layer for perovskite solar cells. By stacking two types of titanium oxide that share the same crystal phase but possess different microstructures, the team achieved a power generation efficiency increase of approximately 10% over single-layer titanium oxide configurations.

Technical Details

The development utilizes a proprietary low-temperature chemical synthesis method to create rutile-phase titanium oxide particles of several tens of nanometers in size. The morphology of these particles varies based on the synthesis temperature:

- 50°C: Bundle-shaped particles
- 60°C: Grain-shaped particles

These two distinct morphologies were applied sequentially onto an electrode and subjected to heat treatment at 500°C. Because the two layers possess different electronic properties (energy levels), they create an "energy staircase" that facilitates the movement of electrons toward the electrode.

Background and Context

The electron transport layer is a critical component of solar cells, responsible for extracting electrons generated by light from the power generation layer and transporting them to the electrode. While titanium oxide and tin oxide are commonly used, optimizing this layer remains a primary challenge in the development of perovskite solar cells.

Significance and Outlook

By using the same crystal phase rather than the different materials used in current mainstream stacked types, this method is expected to reduce interface mismatch and simplify production processes for commercialization. Because the low-temperature chemical synthesis method can produce titanium oxide particles with various electronic properties, the researchers intend to develop customized electron transport layers optimized for a diverse range of perovskite layers by combining multiple layers with different electronic properties.

Source: https://newswitch.jp/p/50634

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

#12 Hemispherical Perovskite Solar Cells: Angle-Robust Design Specs

Published October 23, 2026 pv magazine China

OVERVIEW

Researchers in China have developed a hemispherical perovskite solar cell with a textured surface that reduces power fluctuations caused by varying sunlight angles. The textured rounded-cone design achieved an average short-circuit current density of 25.47 mA/cm², significantly outperforming planar devices. This architecture enables more stable energy yields for renewable power generation by decoupling performance from the angle of incidence.

IN DEPTH

Key Findings

The textured rounded-cone hemispherical solar cell demonstrated superior performance across incidence angles from 0° to 50°, achieving an average short-circuit current density of 25.47 mA/cm² and an average maximum power output of 28.25 mW/cm². Light absorption for this design exceeded 95%. In comparison, the smooth hemispherical cell reached 24.03 mA/cm² and the planar device reached 22.52 mA/cm² for average short-circuit current density.

Technical Details

The research team modeled five distinct architectures: planar, nanowire, smooth hemispherical, and hemispherical structures featuring either rounded-cone or textured rounded-cone front surfaces. The device stack consists of the following layers:

- Indium tin oxide (ITO) electrode
- Phenyl-C61-butyric acid methyl ester (PCBM) electron transport layer
- Methylammonium lead iodide ($CH_3NH_3PbI_3$) perovskite absorber
- Nickel oxide (NiO) hole transport layer
- Silver (Ag) rear electrode

Using Lumerical software, the team simulated light absorption, scattering, electromagnetic fields, and charge generation for wavelengths between 300 nm and 800 nm. These profiles were integrated into electrical simulations to analyze carrier transport, recombination, and current-voltage characteristics.

Background and Context

While perovskite solar cells are noted for low manufacturing costs and high power conversion efficiency, conventional planar designs suffer from optical losses when the solar incidence angle varies. This leads to power fluctuations that compromise practical energy yields. The proposed hemispherical geometry is designed to enable radial charge collection, while the textured surface scatters incoming light to promote uniform charge generation.

Significance and Outlook

The study, published in *Solar Energy* by scientists from the Chinese Academy of Sciences and Jilin Normal University, concludes that the three-dimensional hemisphere symmetry balances carrier transport. Furthermore, the use of Mie resonances within the perovskite shell ensures efficient light trapping, effectively overcoming the challenge of angular-dependent power output.

Source: https://www.pv-magazine.com/2026/10/23/hemispherical-perovskite-solar-cell-design-reduces-sensitivity-to-sunlight-angle/

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

#13 Perovskite Solar Cells: KIER and UNIST Stability Process 2026

Published October 27, 2026 xenospectrum South Korea

OVERVIEW

Researchers from KIER and UNIST have developed a catalytic filtration process that allows perovskite solar cells to retain 95% of their initial efficiency after 1,000 hours of damp-heat testing. By removing degradation-causing components before film formation, the team addressed the trade-off between power conversion efficiency and durability. This method demonstrates a path toward improving the long-term stability of organic semiconductor layers in solar devices.

IN DEPTH

Key Findings

A joint research team led by Dr. SeJin Ahn (KIER) and Dr. Dong Suk Kim (UNIST) has developed a manufacturing process that enables perovskite solar cells to retain 95% of their initial conversion efficiency after 1,000 hours of exposure to 85°C and 85% relative humidity. In separate maximum power point tracking (MPPT) tests under 1 sun illumination (1,000 watts per square meter), devices produced via this process retained more than 90% of their initial efficiency after 500 hours, significantly outperforming comparison devices.

Technical Details

The team targeted the hole transport layer (HTL), specifically the organic semiconductor spiro-OMeTAD. To improve conductivity, spiro-OMeTAD is typically p-doped using lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) and 4-tert-butylpyridine (tBP). However, volatile tBP and mobile lithium ions (Li^+) often trigger degradation through ion migration and the formation of voids. The new process utilizes micrometer-sized nickel oxide (NiO_x) powder added to the precursor solution to achieve the following:

- **Accelerated Oxidation:** NiO_x promotes the redox reactions that oxidize spiro-OMeTAD to generate necessary radical cations.
- **Ion Capture:** The NiO_x particles capture lithium ions on their surfaces.
- **Filtration:** The NiO_x and captured ions are filtered out of the solution before the film is formed, removing degradation-causing components while maintaining efficiency.

Background and Significance

The findings, published in *Advanced Science* on January 26, 2026, address a long-standing trade-off where reducing additives to improve durability typically resulted in insufficient conductivity and lower power conversion efficiency (PCE). By performing the oxidation in solution and removing the catalysts via filtration, the team avoided the need for conventional additives that compromise stability.

While the 1,000-hour damp-heat test is a standard for international reliability testing, the researchers note that these laboratory results do not directly prove the 20- to 30-year service life required for commercial rooftop panels, as real-world conditions involve simultaneous exposure to light, heat, moisture, and electrical load.

Source: https://xenospectrum.com/en/kier-perovskite-solar-cell-catalytic-filtration-damp-heat-stability/

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

#14 Perovskite Solar Cells: Flexible Modules with 26.9% Efficiency

Published October 28, 2026 Yahoo Nachrichten DE Germany

OVERVIEW

Researchers from Southeast University and Soochow University have developed flexible perovskite solar cells achieving a peak efficiency of 26.9%. By utilizing a new coating process to maintain high performance in larger modules, the technology enables power generation on curved surfaces like vehicle roofs and backpacks.

IN DEPTH

Key Findings

Chinese scientists have achieved a power conversion efficiency of 26.9% for flexible solar cells. A critical breakthrough is the ability to scale these cells without the significant performance drops typical of flexible modules. Specifically, the team achieved record efficiencies across three different module sizes: 22.31% for 25 square centimeters, 20.63% for 100 square centimeters, and 20.15% for 900 square centimeters (where the active solar area is 750 square centimeters).

Technical Details

The research, published in *Science*, focuses on perovskite materials deposited on thin plastic foils. To solve the issue of irregular crystal growth and poor adhesion on flexible substrates, the team developed a manufacturing process that separates two chemical reactions. By introducing a specially developed additive molecule, they prevented interfering interactions between the light-absorbing perovskite and the thin transport layer. This ensures a more uniform coating and controlled crystal growth, reducing material defects and improving power yield on larger surfaces.

Durability and Testing

The modules were subjected to rigorous stress tests, including temperature cycling between -40 and +85 degrees Celsius. In a long-term stability test, a module operated for 1,044 hours at 85 degrees Celsius and 65% relative humidity while continuously providing electrical power; it retained approximately 92% of its original efficiency. The modules also met all requirements of the international standard IEC TS 63163 for flexible photovoltaic modules.

Significance and Outlook

While the process provides a technical foundation for integrating solar power into curved surfaces, such as automotive roofs and wearable gear, the researchers noted that long-term outdoor operation and mass-production readiness have not yet been demonstrated. Future development will focus on roll-to-roll manufacturing to enable high-volume production and investigating the compatibility of this process with tandem solar cells that combine multiple light-absorbing layers.

Source: https://de.nachrichten.yahoo.com/flexible-solarzellen-26-9-prozent-131458373.html

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

#15 Lead-Free Perovskite Solar Cells: Sophia University's Stability Fix

Published October 27, 2026 索比光伏网 (SolarBE) China

OVERVIEW

Researchers at Sophia University have developed a lead-free perovskite solar cell using tin to improve environmental safety and durability. By implementing a layered structure with organic molecules, the team maintained approximately 85% of initial performance after 100 days.

IN DEPTH

Key Findings

Sophia University and its partners have developed a new lead-free perovskite solar cell technology that replaces toxic lead with tin. This approach simultaneously addresses the challenges of conversion efficiency and durability, with the cells maintaining approximately 85% of their initial performance over a period of 100 days.

Technical Details

The research team designed the perovskite layer as a stacked structure consisting of alternating conductive layers made of tin and iodine, and non-conductive organic molecule layers. The primary functions of these organic molecule layers are as follows:

- Prevention of water and oxygen penetration to enhance overall durability.
- Mitigation of tin oxidation, which typically destroys the crystal structure.

To counteract the increased electrical resistance caused by the introduction of organic molecule layers—which typically lowers conversion efficiency—the team utilized specific additives to suppress efficiency loss. The study is detailed in the paper "Molecular Passivation with 2-Aminobenzothiazole Enables Efficient and Stable Ruddlesden–Popper Tin Perovskite Solar Cells" (DOI: doi.org/10.1002/solr.70388).

Background & Context

Perovskite cells typically use atoms such as iodine and lead to form a specific crystal structure for light absorption. While lead-based cells are efficient, the toxicity of lead poses environmental and safety risks. Tin is a viable alternative due to its similar properties, but its tendency to oxidize has historically made it difficult to achieve a balance between stability and efficiency.

Significance & Outlook

Professor Yuko Takeoka of Sophia University emphasizes that lead-free cells are critical for applications in spaces close to human living environments. While the current conversion efficiency of this tin-based cell remains lower than that of lead-containing perovskite cells, the research team is now focusing on increasing efficiency and scaling the technology for large-area production.

Source: https://news.solarbe.com/202610/27/50030997.html

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