TROY TECHNICAL

PEROVSKITE SOLAR CELLS

WEEKLY REPORT

October 31 - November 6, 2026 | Issue 2026-W44

Bankable module performance, durability, manufacturing yield and market entry

15	10
ANALYZED ARTICLES	PRIORITY THEMES

Issued 2026-11-06 | 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/Silicon Tandem Solar Cells: 35.1% PCE via SAMs

Researchers have achieved a certified stabilized power conversion efficiency (PCE) of 35.1% in perovskite/silicon tandem solar cells by engineering self-assembled monolayers (SAMs) with tailored intramolecular distortion.

SIGNAL 02 | CELL STACK

Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE

Researchers have developed a method to transform PbI2 clusters into nanowires to serve as scaffolds for perovskite film formation. This approach achieved a champion power conversion efficiency (PCE) of 26.94% in lab-scale devices and 24.60% in micro modules.

SIGNAL 03 | MODULE PROCESS

Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs

Researchers at Sungkyunkwan University (SKKU) have developed a low-defect perovskite semiconductor thin film using a volatile eutectic mixture.

SIGNAL 04 | QUALIFICATION

Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF

Researchers have identified the fill factor (FF) as the primary driver of efficiency loss when scaling perovskite solar cells from small areas to modules.

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

35.1%
A01

SOURCE-BOUND CONDITION
Researchers have achieved a certified stabilized power conversion efficiency (PCE) of 35.1% in perovskite/silicon tandem solar cells by engineering self-assembled monolayers (SAMs) with tailored intramolecular.

26.94%
A05

SOURCE-BOUND CONDITION
This approach achieved a champion power conversion efficiency (PCE) of 26.94% in lab-scale devices and 24.60% in micro modules.

0.3 cm
A13

SOURCE-BOUND CONDITION
The process achieved a record-low surface recombination velocity of 0.3 cm/s, enabling both a 26.5% efficient solar cell and a 26.1% external quantum efficiency LED using the same material platform.

19.48 cm
A04

SOURCE-BOUND CONDITION
By utilizing cryo-controlled processing to regulate crystallization, a mini-module with a 19.48 cm2 aperture achieved a record certified steady-state efficiency of 23.9%.

36.2 mW
A03

SOURCE-BOUND CONDITION
By suppressing microstrain accumulation, these cells achieved a power-generation density of 36.2 mW cm-2 and retained 90% efficiency after 1,000 hours of testing.

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 have achieved a certified stabilized power conversion efficiency (PCE) of 35.1% in perovskite/silicon tandem.

2

Cell stack

P02/P07

Researchers have developed a method to transform PbI2 clusters into nanowires to serve as scaffolds for perovskite film.

3

Module proce ss

P03/P08

Researchers at Sungkyunkwan University (SKKU) have developed a low-defect perovskite semiconductor thin film using a volatile.

4

Qualification

P04/P09

Researchers have identified the fill factor (FF) as the primary driver of efficiency loss when scaling perovskite solar cells.

5

Deployment & recycling

P05/P10

Researchers have identified perovskite lattice compliance as a key materials descriptor for improving the photothermal.

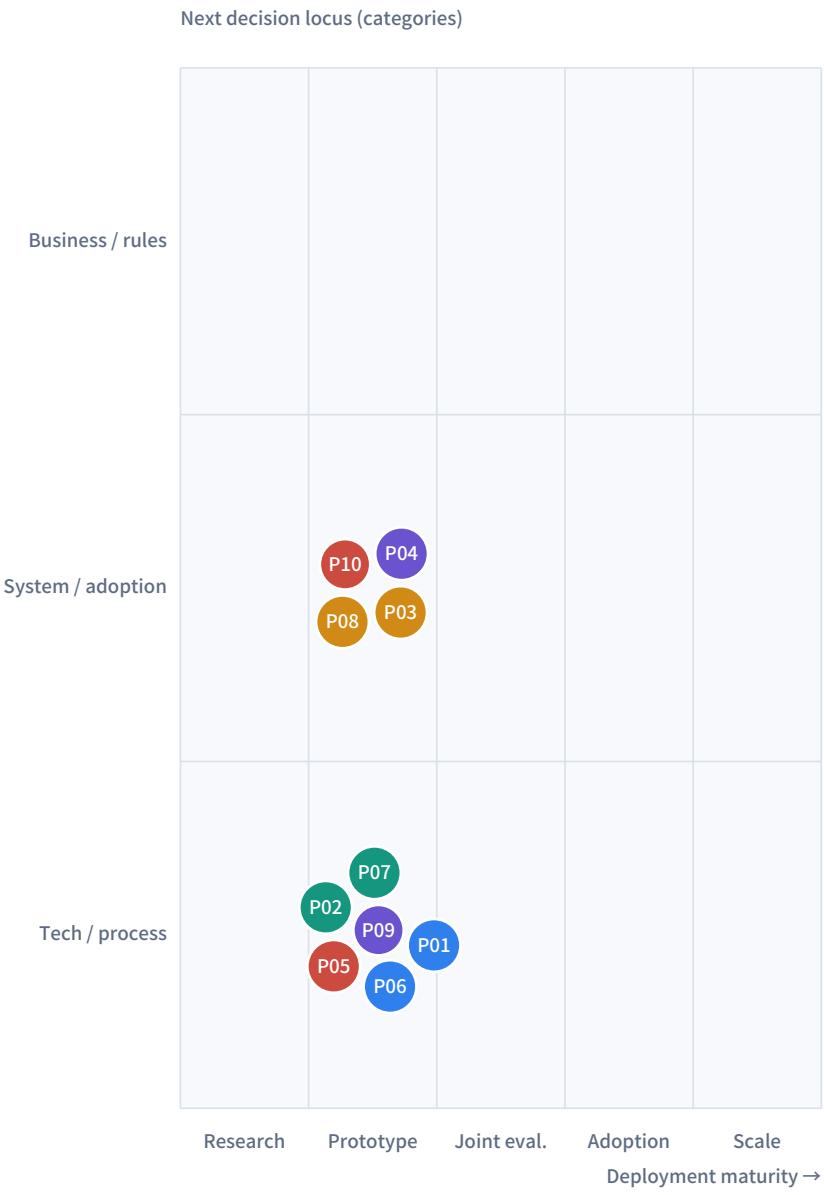
EVIDENCE REQUIRED AT EACH HANDOFF

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/Silicon Tandem Solar Cells: 35.1% PCE via SAMs Tech / process | cue: no system/business cue
P02	Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE Tech / process | cue: no system/business cue
P03	Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs System / adoption | cue: platform
P04	Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF System / adoption | cue: Scale-up
P05	Perovskite Lattice Compliance: Stability in Bifacial Tandem PVs Tech / process | cue: no system/business cue
P06	Perovskite Solar Cells: 26.5% Efficiency via Defect Reduction Tech / process | cue: no system/business cue
P07	TPE-BTA3 Molecule: Pushing Tandem Solar Cell Efficiency to 26.5% Tech / process | cue: no system/business cue
P08	Perovskite Mini-Modules: 23.9% Efficiency via Fill Factor Retention System / adoption | cue: scale-up
P09	FA-Cs Perovskites: Cation Heterogeneity and Stability Solutions Tech / process | cue: no system/business cue
P10	Perovskite Solar Cells: g-C3N4 Buffer Layer for 27.05% Efficiency System / adoption | cue: commercialization

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/Silicon Tandem Solar Cells: 35.1% PCE via SAMs

A01 | Precursors | Pilot

2026-11-04

FACT

Researchers have achieved a certified stabilized power conversion efficiency (PCE) of 35.1% in perovskite/silicon tandem solar cells by engineering self-assembled monolayers (SAMs) with tailored intramolecular distortion. This approach resolves the trade-off between conductivity and conformal coverage on rough textured substrates, significantly improving device stability and fill factor.

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

P02 Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE

A05 | Cell stack | Pilot

2026-10-31

FACT

Researchers have developed a method to transform PbI2 clusters into nanowires to serve as scaffolds for perovskite film formation. This approach achieved a champion power conversion efficiency (PCE) of 26.94% in lab-scale devices and 24.60% in micro modules. The technique enables high homogeneity and crystallinity across both small and large-area 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 P02.

UNKNOWN

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

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

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

P03 Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs

A13 | Module process | Pilot

2026-11-04

FACT

Researchers at Sungkyunkwan University (SKKU) have developed a low-defect perovskite semiconductor thin film using a volatile eutectic mixture. The process achieved a record-low surface recombination velocity of 0.3 cm/s, enabling both a 26.5% efficient solar cell and a 26.1% external quantum efficiency LED using the same material platform.

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 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

P04 Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF

A04 | Qualification | Pilot

2026-10-29

FACT

Researchers have identified the fill factor (FF) as the primary driver of efficiency loss when scaling perovskite solar cells from small areas to modules. By utilizing cryo-controlled processing to regulate crystallization, a mini-module with a 19.48 cm2 aperture achieved a record certified steady-state efficiency of 23.9%. This finding links FF preservation directly to both scale-up performance and long-term operational stability.

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 Perovskite Lattice Compliance: Stability in Bifacial Tandem PVs

A03 | Deployment & recycling | Pilot

2026-10-29

FACT

Researchers have identified perovskite lattice compliance as a key materials descriptor for improving the photothermal stability of bifacial perovskite/silicon tandem solar cells. By suppressing microstrain accumulation, these cells achieved a power-generation density of 36.2 mW cm-2 and retained 90% efficiency after 1,000 hours of 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 P05.

UNKNOWN

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

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

P06 Perovskite Solar Cells: 26.5% Efficiency via Defect Reduction

A15 | Precursors | Pilot

2026-11-02

FACT

Researchers from Argonne National Laboratory, Sungkyunkwan University, and other institutions have developed a crystal growth technique that reduces defects in perovskite materials. This method achieved a 26.5% energy conversion efficiency in small-scale solar cells and demonstrated improved durability under high-temperature conditions.

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

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

P07 TPE-BTA3 Molecule: Pushing Tandem Solar Cell Efficiency to 26.5%

A11 | Cell stack | Pilot

2026-11-01

FACT

Researchers have achieved a power conversion efficiency of 26.5% (certified at 25.8%) in perovskite-organic tandem solar cells by utilizing a novel AIE-active molecule. By reducing non-radiative recombination losses through a rotor-shaped molecular design, the device overcomes traditional voltage deficits in organic sub-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 P07.

UNKNOWN

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

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

P08 Perovskite Mini-Modules: 23.9% Efficiency via Fill Factor Retention

A14 | Module process | Pilot

2026-11-06

FACT

Researchers have achieved a certified steady-state efficiency of 23.9% in a 19.48 cm2 perovskite mini-module by mitigating fill factor loss during scale-up. The team utilized a cryo-controlled processing step to reduce diode non-ideality, linking efficiency retention in larger devices to long-term operational stability.

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

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

P09 FA-Cs Perovskites: Cation Heterogeneity and Stability Solutions

A07 | Qualification | Pilot

2026-11-04

FACT

Researchers have identified that Cs-enriched grain triple junctions act as the primary initiation points for ambient degradation in formamidinium-caesium mixed-cation perovskites. By introducing N-Octylsulfobetaine to homogenize cation distribution, the team achieved a power conversion efficiency of 26.37% and 96.47% performance retention after 2,200 h. This discovery provides a nanoscopic pathway to enhance the long-term durability of perovskite photovoltaics.

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: g-C3N4 Buffer Layer for 27.05% Efficiency

A06 | Deployment & recycling | Pilot

2026-10-30

FACT

Researchers have developed a multifunctional buffer layer using graphitic carbon nitride (g-C3N4) to mitigate mechanical mismatch in inverted perovskite solar cells (PSCs). The resulting devices achieve 27.05% efficiency and retain over 90% of this performance after 1056 h of maximum power point tracking under day-night cycling. This approach addresses interfacial delamination, a critical bottleneck for the commercialization of durable photovoltaics.

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/Silicon Tandem Solar Cells: 35.1% PCE via SAMs	https://www.nature.com/articles/s41586-026-11226-8
A02	Cs(FA)PbI3 Tandem Solar Cells: 32.08% Efficiency via Metallomesogen	https://www.nature.com/articles/s41560-026-02161-z
A03	Perovskite Lattice Compliance: Stability in Bifacial Tandem PVs	https://www.nature.com/articles/s41560-026-02162-y
A04	Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF	https://www.nature.com/articles/s41467-026-78867-1
A05	Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE	https://www.nature.com/articles/s41467-026-79173-6
A06	Perovskite Solar Cells: g-C3N4 Buffer Layer for 27.05% Efficiency	https://www.nature.com/articles/s41467-026-79172-7
A07	FA-Cs Perovskites: Cation Heterogeneity and Stability Solutions	https://www.nature.com/articles/s41467-026-79158-5
A08	Longi Perovskite-Silicon Tandem Cell: 35.31% Efficiency via SAMs	https://www.pv-magazine.com/2026/11/06/longi-achieves-35-31-efficiency-in-perovskite-silicon-tandem-solar-cell-based-on-self-assembled-molecules/

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	Perovskite Solar Cells: PolyU Fixes Aging via Grain Boundaries	https://www.miragenews.com/research-finds-hidden-cause-of-perovskite-solar-1771770/
A10	KIT Perovskite-Silicon Tandems: 30.2% Efficiency via Inkjet Printing	https://taiyangnews.info/technology/kit-achieves-302-efficiency-in-inkjet-printed-tandem-cells
A11	TPE-BTA3 Molecule: Pushing Tandem Solar Cell Efficiency to 26.5%	https://energiesmedia.com/molecule-glows-clusters-solar-efficiency/
A12	Perovskite Solar Cells: PEAI Concentration for Efficiency and Stability	http://www.mjeonbuk.com/news/articleView.html?idxno=149836
A13	Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs	https://www.newswise.com/articles/skku-develops-ultra-low-defect-semiconductor-thin-films-through-eutectic-engineering-enabling-both-solar-cells-and-leds
A14	Perovskite Mini-Modules: 23.9% Efficiency via Fill Factor Retention	https://www.perovskite-info.com/fill-factor-retention-helps-perovskite-mini-module-reach-certified-239
A15	Perovskite Solar Cells: 26.5% Efficiency via Defect Reduction	https://www.esnews.kr/news/articleView.html?idxno=7136

PerovskiteSolarCells — Selected Articles

Date: 2026-11-08

Articles: 15

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#04 Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF

#05 Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE

#06 Perovskite Solar Cells: g-C3N4 Buffer Layer for 27.05% Efficiency

#07 FA-Cs Perovskites: Cation Heterogeneity and Stability Solutions

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#13 Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs

#14 Perovskite Mini-Modules: 23.9% Efficiency via Fill Factor Retention

#15 Perovskite Solar Cells: 26.5% Efficiency via Defect Reduction

#01 Perovskite/Silicon Tandem Solar Cells: 35.1% PCE via SAMs

Published November 04, 2026 Nature



OVERVIEW

Researchers have achieved a certified stabilized power conversion efficiency (PCE) of 35.1% in perovskite/silicon tandem solar cells by engineering self-assembled monolayers (SAMs) with tailored intramolecular distortion. This approach resolves the trade-off between conductivity and conformal coverage on rough textured substrates, significantly improving device stability and fill factor.

IN DEPTH

Key Findings

The optimized perovskite/silicon tandem solar cell achieves a certified stabilized power conversion efficiency (PCE) of 35.1% and a fill factor (FF) of 85%. In terms of durability, the device retains more than 94% of its initial performance after 1,500 hours of ageing under the ISOS-L-1 protocol.

Technical Details

The performance gains are attributed to the use of rationally engineered molecular spatial conjugation within the self-assembled monolayer (SAM). The design incorporates tailored intramolecular distortion to suppress excess π–π stacking, which prevents unfavorable aggregation without reducing charge-transport efficiency. This steric regulation enables the formation of a highly ordered, conformal SAM across rough pyramidal textures.

This tailored interface provides several critical technical advantages:

- Optimized energy-level alignment for ultrafast charge extraction.
- Improved defect passivation through adaptive conformational adjustment.
- A robust template that supports the growth of high-quality perovskite films.

Background & Context

Current perovskite/silicon tandem solar cells utilizing rough textured substrates face a critical design trade-off regarding SAMs. While increasing molecular conjugation typically enhances conductivity, it often leads to aggregation that impairs the conformal coverage of the substrate. This limitation has historically hindered the ability to maintain both high conductivity and film uniformity on textured silicon.

Significance & Outlook

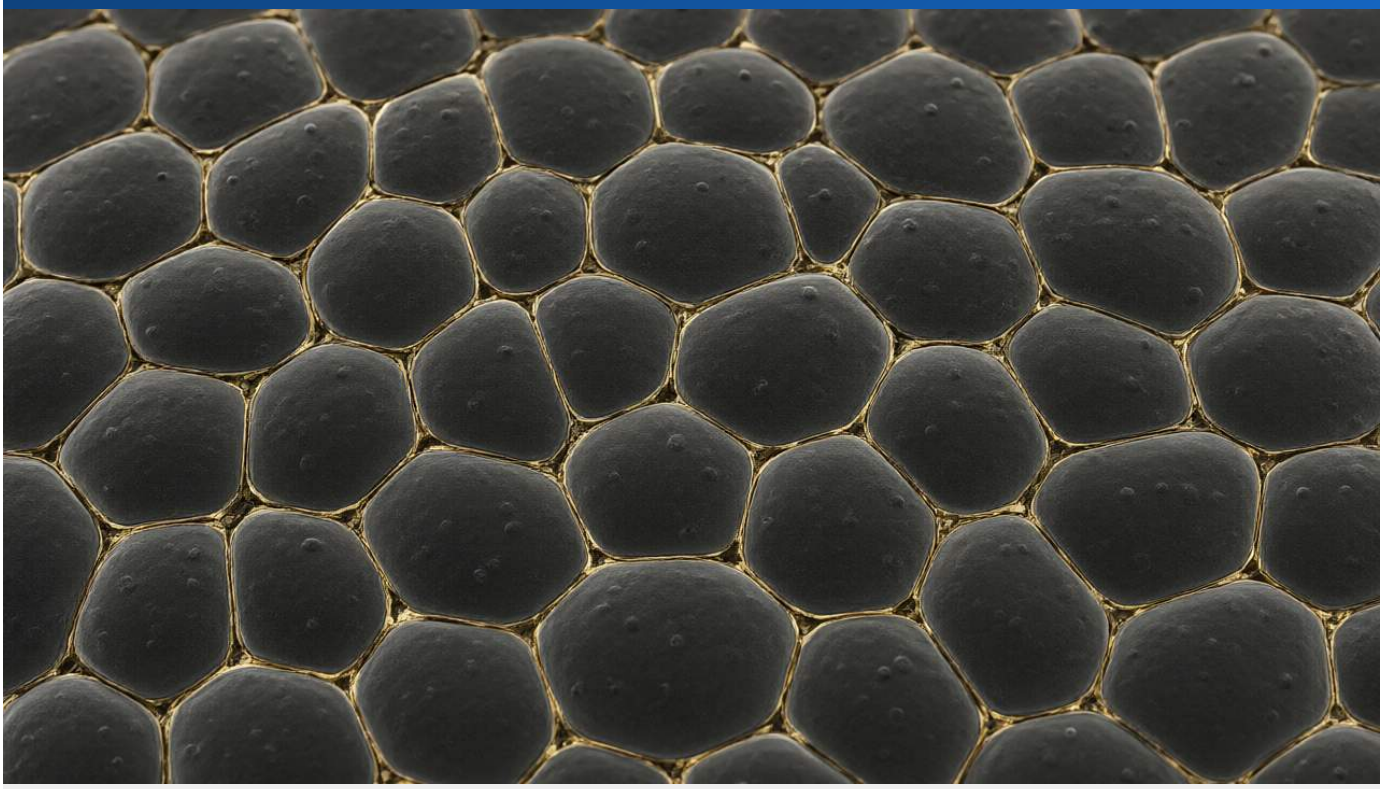
By reconciling molecular packing with interfacial coverage, this molecular engineering route provides a method to maximize the performance of tandem photovoltaics on textured silicon substrates. The ability to maintain high efficiency while ensuring long-term stability under ISOS-L-1 protocols represents a significant step in the development of high-performance tandem solar cells.

Source: https://www.nature.com/articles/s41586-026-11226-8

Collected: November 07, 2026 | Automated Research System (AI)

#02 Cs(FA)PbI3 Tandem Solar Cells: 32.08% Efficiency via Metallomesogen

Published November 02, 2026 Nature Energy



OVERVIEW

Researchers have achieved a champion efficiency of 32.08% (certified 31.62%) in perovskite/silicon tandem solar cells by using a Pb-based metallomesogen to engineer grain boundaries. This approach mitigates defect formation and strain in Cs(FA)PbI3 absorbers, significantly enhancing both power conversion efficiency and long-term stability.

IN DEPTH

Key Findings

The integration of a Br-containing grain boundary (GB) modifier into a 1.66-eV Cs(FA)PbI3 absorber has resulted in a perovskite/silicon tandem solar cell with a champion efficiency of 32.08% and a certified efficiency of 31.62%. Beyond efficiency, the device demonstrates high durability, retaining 95% of its initial performance after approximately 3,000 hours of maximum power point tracking. Additionally, it maintains 93% of its performance after 1,500 hours of damp-heat stressing at 85 °C and 85% relative humidity.

Technical Details

The study identifies that sparse doping of oversized formamidinium (FA) cations in caesium lead triiodide (Cs(FA)PbI3) causes severe grain boundary distortion, which leads to defect generation and performance loss. To resolve this, the researchers developed a Pb-based metallomesogen. This material forms a mesophase that combines solid-like and liquid-like properties, allowing it to distribute uniformly along the grain boundaries of the Cs(FA)PbI3 film.

This uniform distribution provides several structural benefits:

- Alleviation of grain boundary distortion.
- Relief of shear strain.
- Preservation of lattice integrity.
- Mitigation of defect formation.

Background & Context

Cs(FA)PbI3 is considered a promising front-cell absorber for tandem solar cells due to its inherent stability. However, producing high-quality films has remained a significant technical challenge. Previous research in the field has explored various methods to improve efficiency and stability, including interface engineering and the regulation of crystallization in wide-bandgap perovskites.

Significance & Outlook

By addressing the structural distortion caused by FA cation doping, this metallomesogen-based engineering approach provides a pathway to stabilize high-efficiency tandem cells. The ability to maintain high performance under both continuous operational tracking and extreme damp-heat conditions suggests a significant improvement in the commercial viability of perovskite/silicon tandem architectures.

Source: https://www.nature.com/articles/s41560-026-02161-z

Collected: November 07, 2026 | Automated Research System (AI)

#03 Perovskite Lattice Compliance: Stability in Bifacial Tandem PVs

Published October 29, 2026 Nature Energy



OVERVIEW

Researchers have identified perovskite lattice compliance as a key materials descriptor for improving the photothermal stability of bifacial perovskite/silicon tandem solar cells. By suppressing microstrain accumulation, these cells achieved a power-generation density of 36.2 mW cm−2 and retained 90% efficiency after 1,000 hours of testing.

IN DEPTH

Key Findings

Bifacial monolithic perovskite/silicon tandem solar cells have demonstrated a power-generation density of 36.2 mW cm−2 under 0.20 albedo-equivalent illumination. These devices exhibit high stability, retaining 90% of their initial efficiency after more than 1,000 hours of ISOS-L-2 testing, conducted at 65 °C under 1-sun illumination.

Technical Details

The study identifies "perovskite lattice compliance"—the ability of the crystal lattice to elastically accommodate stress—as the governing factor for photothermal stability. The researchers utilized perovskite absorbers with a bandgap of approximately 1.55 eV. This specific composition reduces the reliance on bromide, which largely mitigates light-induced halide segregation.

Higher lattice compliance enhances stability through several mechanisms:

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

Background & Context

Bifacial tandem configurations are pursued to increase area-normalized power output. While reducing bromide content addresses halide segregation, it shifts the primary stability challenge to the intrinsic photothermal resilience of bromide-lean absorbers. This research establishes a physically testable framework to address these resilience issues at the absorber level.

Significance & Outlook

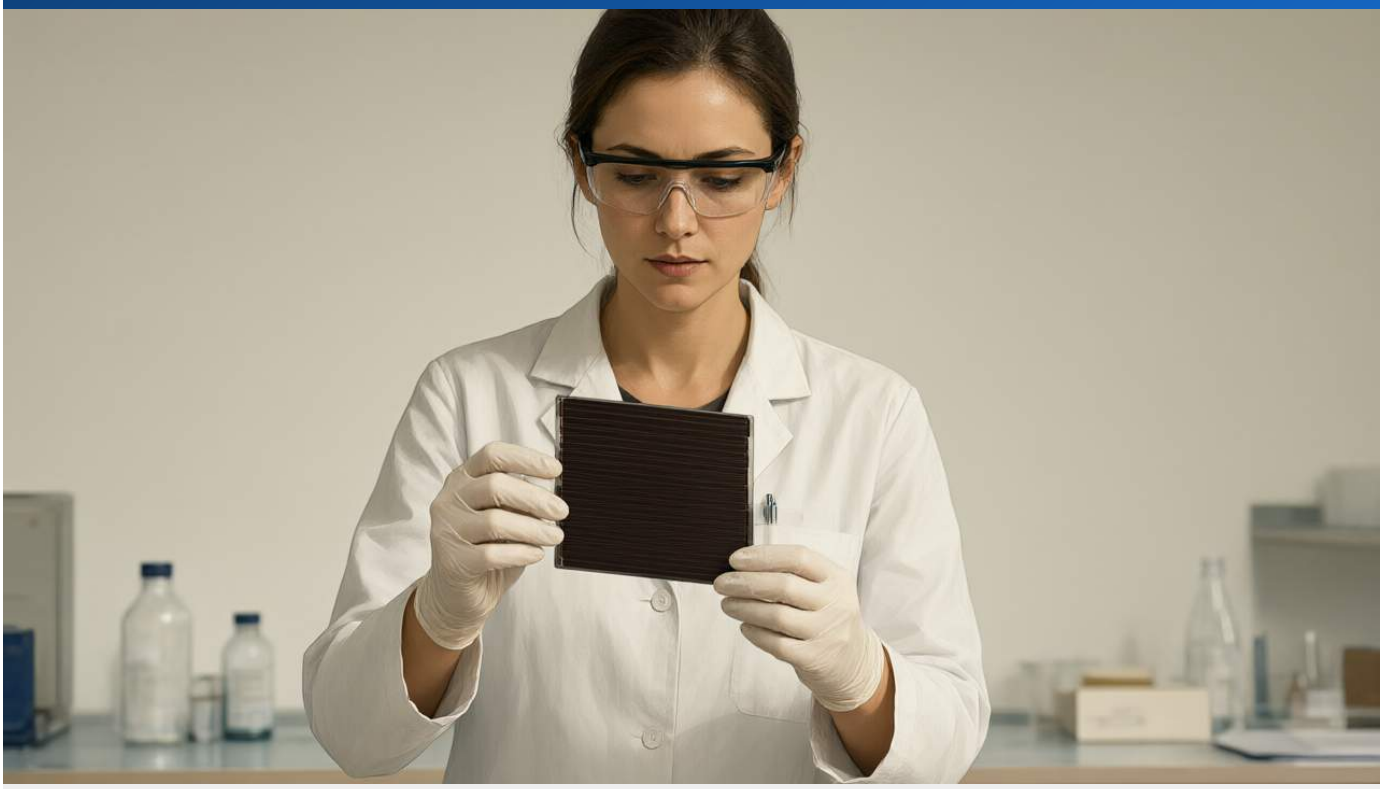
The establishment of lattice compliance as a materials descriptor provides a design principle for creating more stable perovskite absorbers. By focusing on the elastic properties of the crystal lattice to mitigate thermal stress, this approach offers a pathway toward more durable and efficient bifacial perovskite/silicon tandem photovoltaics.

Source: https://www.nature.com/articles/s41560-026-02162-y

Collected: November 07, 2026 | Automated Research System (AI)

#04 Perovskite Photovoltaics: Mitigating Scale-up Efficiency Loss via FF

Published October 29, 2026 Nature Communications China



OVERVIEW

Researchers have identified the fill factor (FF) as the primary driver of efficiency loss when scaling perovskite solar cells from small areas to modules. By utilizing cryo-controlled processing to regulate crystallization, a mini-module with a 19.48 cm² aperture achieved a record certified steady-state efficiency of 23.9%. This finding links FF preservation directly to both scale-up performance and long-term operational stability.

IN DEPTH

Key Findings

The study identifies the fill factor (FF) as the major contributor to efficiency loss during the scale-up of perovskite photovoltaics. By addressing the FF deficit, the researchers developed a mini-module with a 19.48 cm² aperture that reached a record certified steady-state efficiency of 23.9% and an FF of 83.3%, the highest reported for perovskite modules.

Technical Details

The analysis decomposes the FF deficit into three primary contributions: voltage, transport-associated, and diode-non-ideality. To mitigate these losses, the team implemented cryo-controlled processing, which regulates the evolution of the intermediate phase during the crystallization process. The resulting preservation of the FF is predominantly attributed to a reduction in diode non-ideality, with other contributions playing a smaller role. This performance advantage becomes more pronounced as the device scale increases.

Background & Context

While perovskite solar cells can approach the efficiencies of crystalline-silicon at small scales, substantial performance drops typically occur during the transition to practical modules. This research quantifies how various device-performance parameters contribute to this loss across diverse perovskite technologies, establishing a framework to target the specific bottlenecks hindering commercial translation.

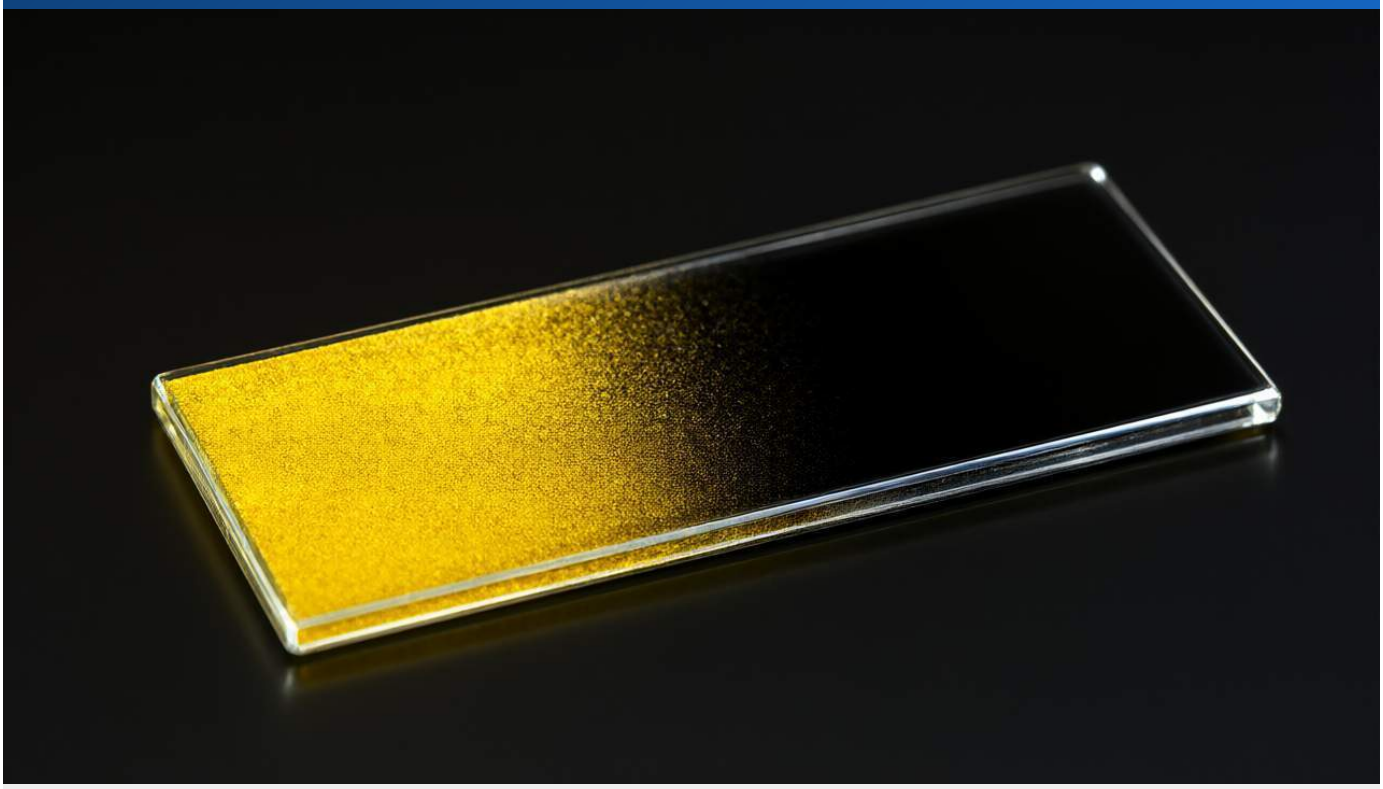
Significance & Outlook

The research establishes a critical link between efficiency retention during scale-up and long-term operational stability, noting that the same FF limitations govern performance decay during operation. Consequently, the preservation of the fill factor and the understanding of the factors governing it are central to reducing performance loss in both the scaling and operational phases of perovskite photovoltaic deployment.

Source: https://www.nature.com/articles/s41467-026-78867-1

#05 Perovskite Solar Cells: Vertical PbI2 Growth for 26.94% PCE

Published October 31, 2026 Nature Communications China



OVERVIEW

Researchers have developed a method to transform PbI2 clusters into nanowires to serve as scaffolds for perovskite film formation. This approach achieved a champion power conversion efficiency (PCE) of 26.94% in lab-scale devices and 24.60% in micro modules. The technique enables high homogeneity and crystallinity across both small and large-area devices.

IN DEPTH

Key Findings

The study reports a champion power conversion efficiency (PCE) of 26.94% (certified as 26.66%) for laboratory-area perovskite devices with an aperture area of 0.0618 cm². Additionally, the researchers successfully manufactured a micro module device with a larger aperture area of 21.54 cm², achieving a PCE of 24.60% (certified as 24.02%).

Technical Details

The performance gains are attributed to a solution-based induction process used during the two-step sequential deposition. This process transforms initial PbI2 clusters into PbI2 nanowires, which act as scaffolds for subsequent perovskite formation. The technical validation included:

- **In-situ GISAXS:** In-plane low-angle diffraction detected a periodically arranged ordered structure in the PbI2 film.
- **In-situ GIWAXS:** Confirmed that the PbI2 nanowires facilitate the ion-exchange process, significantly improving the orientation and homogeneity of the resulting perovskite films.

Background & Context

In two-step sequential deposition, the morphology of the initial PbI2 film is pivotal in determining the crystallinity and uniformity of the final perovskite layer. By introducing a controllable morphology via nanowire formation, the researchers addressed the challenge of maintaining high efficiency when scaling from lab-scale to larger modules.

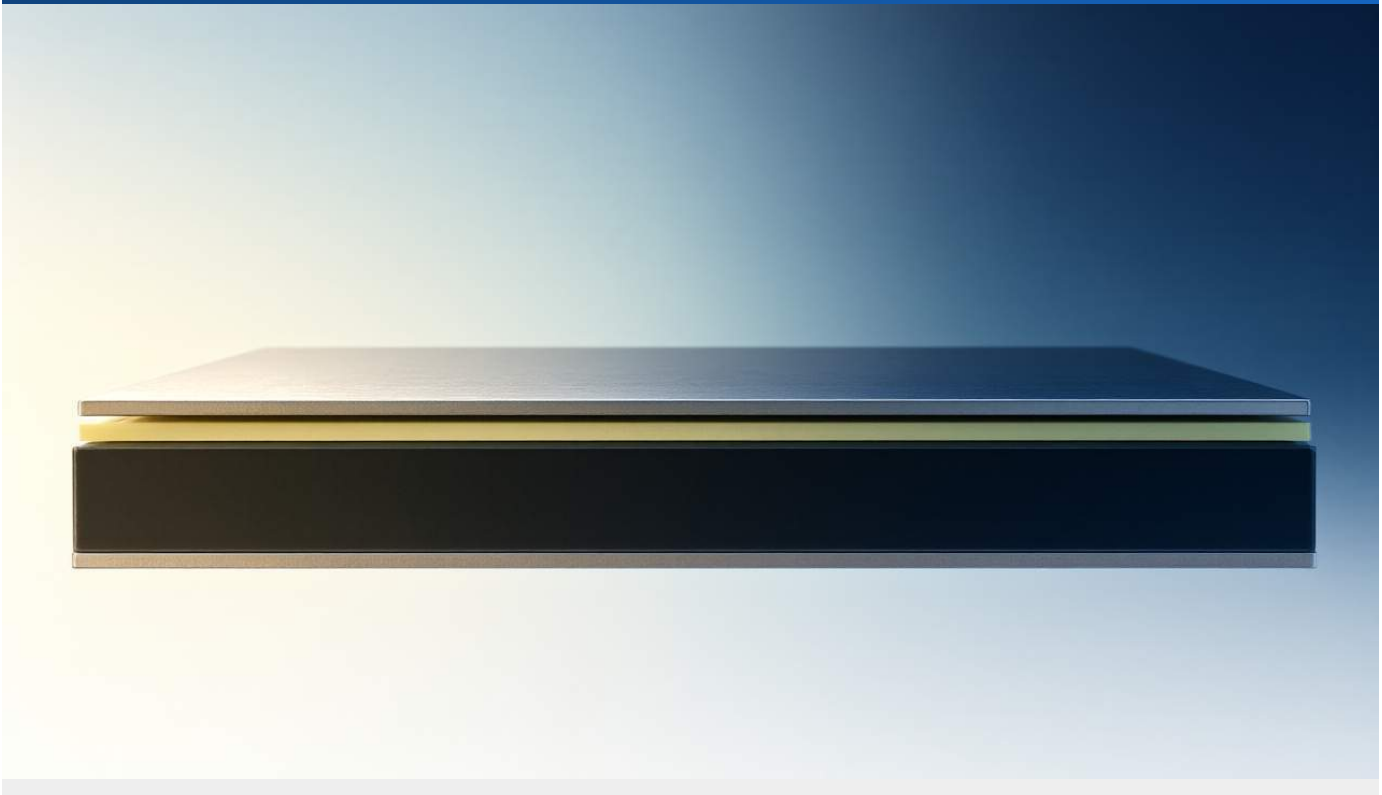
Significance & Outlook

The ability to maintain a certified PCE of 24.02% in a 21.54 cm² micro module demonstrates the scalability of the vertical PbI2 homogeneous growth method. This approach provides a pathway for producing high-performance n-i-p structured perovskite devices with consistent crystallinity across varying surface areas.

Source: https://www.nature.com/articles/s41467-026-79173-6

#06 Perovskite Solar Cells: g-C3N4 Buffer Layer for 27.05% Efficiency

Published October 30, 2026 Nature Communications China



OVERVIEW

Researchers have developed a multifunctional buffer layer using graphitic carbon nitride (g-C3N4) to mitigate mechanical mismatch in inverted perovskite solar cells (PSCs). The resulting devices achieve 27.05% efficiency and retain over 90% of this performance after 1056 h of maximum power point tracking under day-night cycling. This approach addresses interfacial delamination, a critical bottleneck for the commercialization of durable photovoltaics.

IN DEPTH

Key Findings

The integration of a graphitic carbon nitride (g-C3N4) buffer layer has enabled inverted perovskite solar cells (PSCs) to reach a power conversion efficiency of 27.05%. Beyond efficiency, the devices demonstrate significant operational stability, maintaining more than 90% of their initial efficiency after 1056 h of maximum power point tracking during realistic day-night cycling.

Technical Details

The study identifies a specific failure mechanism at the C60/atomic layer deposition (ALD)-SnO2 interface. A severe mismatch in the mechanical properties of these layers leads to the accumulation of internal stress, which triggers interfacial delamination and accelerates the degradation of the device. To resolve this, the researchers introduced g-C3N4 as a two-dimensional multifunctional buffer layer between the C60 and ALD-SnO2.

- **Mechanical Function:** The g-C3N4 acts as a compliant mechanical bridge that alleviates stress and suppresses the formation of microcracks.
- **Electrical Function:** The layer simultaneously facilitates electron transport across the interface.

Background and Context

While previous research has focused on managing thermo-mechanical stress within the perovskite layer itself, the degradation of adjacent functional layers during day-night cycling has been largely overlooked. This interfacial instability has remained a critical bottleneck for the commercialization of PSCs, as real-world applications require tolerance to the mechanical stresses induced by diurnal temperature and light fluctuations.

Significance and Outlook

By addressing the mechanical mismatch at the C60/ALD-SnO2 interface, this research provides a practical strategy for enhancing the robustness of inverted PSCs. The findings advance the fundamental understanding of interfacial failure mechanisms and offer a scalable method to support the transition of durable perovskite photovoltaics from the laboratory to commercial application.

Source: https://www.nature.com/articles/s41467-026-79172-7

Collected: November 07, 2026 | Automated Research System (AI)

#07 FA-Cs Perovskites: Cation Heterogeneity and Stability Solutions

Published November 04, 2026 Nature Communications China



OVERVIEW

Researchers have identified that Cs-enriched grain triple junctions act as the primary initiation points for ambient degradation in formamidinium-caesium mixed-cation perovskites. By introducing N-Octylsulfobetaine to homogenize cation distribution, the team achieved a power conversion efficiency of 26.37% and 96.47% performance retention after 2,200 h. This discovery provides a nanoscopic pathway to enhance the long-term durability of perovskite photovoltaics.

IN DEPTH

Key Findings

The study identifies nanoscopic cation heterogeneity as the driving factor behind the ambient instability of formamidinium-caesium (FA-Cs) mixed-cation perovskites. Specifically, Cs-enriched grain triple junctions serve as intrinsic weak points where Cs^+ segregation and phase separation begin upon exposure to ambient conditions. This localized instability leads to structural disordering and the crystallization of δ-$CsPbI_3$, which subsequently spreads into neighboring grains and degrades the perovskite matrix and interfacial optoelectronic properties.

Technical Details

To analyze these degradation pathways, the researchers utilized quasi-in situ scanning transmission electron microscopy. To mitigate the identified instability, they introduced N-Octylsulfobetaine into the fabrication process. This additive performs three primary functions:

- Regulates crystallization kinetics to suppress cation heterogeneity.
- Promotes a more homogeneous distribution of cations across the material.
- Passivates grain boundaries to increase resistance against the intrusion of water and oxygen.

Performance Results

The implementation of N-Octylsulfobetaine resulted in n-i-p perovskite solar cells with a champion power conversion efficiency of 26.37%. In terms of long-term stability, the cells retained 96.47% of their initial performance after 2,200 h of testing under the ISOS-L-1I protocol.

Significance and Outlook

The research clarifies the nanoscopic origins of degradation in FA-Cs perovskites, which has previously limited the efficiency and durability of solar cells. By establishing a strategy to control cation distribution and passivate grain boundaries, the findings offer a pathway toward robust perovskite photovoltaics that combine high power conversion efficiency with the long-term stability required for practical application.

Source: https://www.nature.com/articles/s41467-026-79158-5

Collected: November 07, 2026 | Automated Research System (AI)

#08 Longi Perovskite-Silicon Tandem Cell: 35.31% Efficiency via SAMs

Published November 06, 2026 pv magazine China



OVERVIEW

Longi has achieved a power conversion efficiency of 35.31% in a perovskite-silicon tandem solar cell by utilizing engineered self-assembled molecules (SAMs). This molecular design optimizes charge transport and interface stability on textured surfaces, significantly advancing the performance limits of tandem photovoltaics.

IN DEPTH

Key Findings

Longi has developed a two-terminal monolithic tandem solar cell that reached a champion power conversion efficiency of 35.31%. This device exhibited a short-circuit current density of 20.82 mA/cm2, an open-circuit voltage of 2.007 V, and a fill factor of 84.53%. Independent certification by China's National Center of Inspection on Solar Photovoltaic Products Quality (CPVT) confirmed a reverse-scan efficiency of 35.25% and a stabilized efficiency of 35.13%.

Technical Details

The efficiency gain is attributed to the use of specially designed self-assembled molecules (SAMs) that prevent excessive molecular stacking while maintaining efficient charge transport. Researchers developed four derivatives based on the 4PACz molecule (TC0, TC1, TC2, and TC3). The TC2 variant provided the optimal balance of substrate adhesion and charge transport, achieving over 80% surface coverage on rough, pyramid-textured silicon surfaces.

The TC2-based interface improved the ITO work function and energy-level alignment, which accelerated charge separation and reduced recombination. Furthermore, TC2 promoted controlled perovskite crystallization, resulting in larger grains and higher crystallinity. Photoluminescence measurements for TC2 showed a quantum yield of 1.46% and a quasi-Fermi level splitting of 1.292 eV.

The device architecture consists of:

- A heterojunction (HJT) silicon bottom cell with an ITO recombination layer.
- A TC2-based SAM hole-selective contact.
- A perovskite absorber top cell.
- A stack comprising a lithium fluoride (LiF) interlayer, fullerene (C60) electron transport layer, and tin oxide (SnOx) buffer layer.
- A transparent indium zinc oxide (IZO) electrode, silver (Ag) contact, and magnesium fluoride (MgFx) optical coating.

Stability and Context

Stability tests under the ISOS-L-1 protocol showed the device retained 94% of its initial efficiency after 1,500 hours of continuous operation. Under the ISOS-L-2 protocol (65 C), it retained 82% efficiency after 1,000 hours. This research, published in *Nature*, involved collaborations with Soochow University, Northwestern Polytechnical University, and Hong Kong Polytechnic University.

Significance and Outlook

This development follows a trend of rapid efficiency increases in tandem cells, including a 31.71% certified cell from Northwestern Polytechnical University in December 2025 and a 32.12% certified cell from Soochow University. Longi's latest result demonstrates that optimized molecular interface engineering can simultaneously enhance efficiency, charge transport, and operational stability.

Source: https://www.pv-magazine.com/2026/11/06/longi-achieves-35-31-efficiency-in-perovskite-silicon-tandem-solar-cell-based-on-self-assembled-molecules/

Collected: November 07, 2026 | Automated Research System (AI)

#09 Perovskite Solar Cells: PolyU Fixes Aging via Grain Boundaries

Published November 04, 2026 Mirage News（香港理工大学の発表） China



OVERVIEW

Researchers at The Hong Kong Polytechnic University have identified that uneven charge losses between neighboring crystal grains cause accelerated photodegradation in perovskite solar cells. By applying a 3-fluorophenylethylammonium bromide (m-F-PEABr) compound, the team achieved a power conversion efficiency of 26.55% and a T90 operational lifetime exceeding 2,200 hours.

IN DEPTH

Key Findings

A research team led by Prof. YANG Guang of The Hong Kong Polytechnic University (PolyU), in collaboration with Zhejiang University, has discovered a hidden cause of aging in perovskite solar cells. The study reveals that photodegradation is driven not only by individual grain stability but by the interaction between neighboring grains with different crystal facets. By balancing charge losses at these boundaries, the team produced cells with a power conversion efficiency of 26.55% that retained over 90% of their initial efficiency after more than 2,200 hours of continuous operation under one-sun equivalent light.

Technical Details

The researchers focused on mixed-facet structures where grains with (100) and (111) facets sit side by side. They found that the (111) side of the grain boundary contains more defects, specifically vacancies where formamidinium (FA) ions are missing. This leads to an abnormal build-up of holes on the (111) side, which unexpectedly accelerates the degradation of these grains despite their natural resistance to light-induced aging.

To mitigate this, the team introduced 3-fluorophenylethylammonium bromide (m-F-PEABr). Because the molecules are too bulky to enter the grains, they collect at the grain boundaries. The positively charged end of the molecule fills the FA ion vacancies at the (111) boundaries, while the fluorine-containing segment secures the molecule in place. This repair balances charge losses across the boundaries, removing the focal points for degradation.

Background & Context

Perovskite solar cells are valued for being lightweight, low-cost, and efficient. However, photodegradation during long-term sunlight exposure has remained a primary barrier to large-scale commercialization. While previous research focused on reducing the overall number of defects, this study highlights the role of uneven charge losses between neighboring grains during operation.

Significance & Outlook

The findings, published in the journal Watt and commended by Prof. Nam-Gyu PARK of Sungkyunkwan University, provide a new framework for understanding cell aging. By shifting focus toward the interaction between grains, this approach offers a viable path toward developing more durable and commercially viable perovskite solar technology.

Source: https://www.miragenews.com/research-finds-hidden-cause-of-perovskite-solar-1771770/

Collected: November 07, 2026 | Automated Research System (AI)

#10 KIT Perovskite-Silicon Tandems: 30.2% Efficiency via Inkjet Printing

Published November 02, 2026 TaiyangNews Germany



OVERVIEW

Researchers at the Karlsruhe Institute of Technology (KIT) have achieved a 30.2% power conversion efficiency (PCE) in perovskite-silicon tandem cells using a hybrid inkjet-printing process. This scalable deposition route demonstrates the feasibility of exceeding 30% efficiency while utilizing printing techniques suitable for larger-area fabrication.

IN DEPTH

Key Findings

Researchers at the Karlsruhe Institute of Technology (KIT) have demonstrated a perovskite-silicon tandem cell with a maximum power conversion efficiency (PCE) of 30.2%. This marks the first time a tandem cell exceeding 30% efficiency has been achieved using an inkjet-printing-based process for the perovskite absorber deposition. The champion cell recorded an open-circuit voltage of 1.94 V, a short-circuit current density of 20.4 mA/cm², and a fill factor of 75.8%, maintaining efficiency above 30% during 10 minutes of maximum power point tracking.

Technical Details

The fabrication process utilizes a hybrid approach to deposit the various layers of the monolithic device:

- **Hole Transport Layer (HTL):** A self-assembled monolayer (SAM)-based HTL was deposited via dip-coating, using 2PACz for perovskite-only cells and Ph4PACz for tandem cells on textured silicon.
- **Perovskite Absorber:** A two-step hybrid process was employed, where inorganic precursors were first deposited by thermal evaporation, followed by the inkjet printing of organic precursors.
- **Passivation:** An interfacial passivation layer was applied above the perovskite absorber using dip-coating.

These layers were integrated with textured silicon heterojunction (HJT) bottom cells and a wide-bandgap perovskite top cell.

Scalability and Mini-Module Performance

To test the scalability of the process, the team developed a single-junction perovskite mini-module with an active area of 12.96 cm². The module consists of nine series-connected cell stripes (1.44 cm² each) created via laser scribing. This mini-module achieved a PCE of 17.8%, representing an efficiency loss of 0.53 percentage points per decade of area scaling compared to smaller cells.

Significance and Outlook

While the results validate the potential of inkjet printing and dip-coating for tandem cell production, the researchers noted that the fill factor of 75.8% indicates a need for further optimization of the tandem architecture on textured silicon surfaces. Future development will focus on improving process control and laser-scribing precision to transition this laboratory process into industrial manufacturing.

Source: https://taiyangnews.info/technology/kit-achieves-302-efficiency-in-inkjet-printed-tandem-cells

Collected: November 07, 2026 | Automated Research System (AI)

#11 TPE-BTA3 Molecule: Pushing Tandem Solar Cell Efficiency to 26.5%

Published November 01, 2026 Energies Media



OVERVIEW

Researchers have achieved a power conversion efficiency of 26.5% (certified at 25.8%) in perovskite-organic tandem solar cells by utilizing a novel AIE-active molecule. By reducing non-radiative recombination losses through a rotor-shaped molecular design, the device overcomes traditional voltage deficits in organic sub-cells.

IN DEPTH

Key Findings

The integration of a specifically engineered molecule, TPE-BTA3, has pushed the power conversion efficiency of perovskite-organic tandem solar cells to 26.5%, with independent certification confirming 25.8%. This achievement is driven by the molecule's ability to maintain high luminescence when clustered, which significantly reduces the open-circuit voltage (VOC) deficit typically found in organic solar materials.

Technical Details

TPE-BTA3 utilizes a three-dimensional rotor-stereo configuration to implement Aggregation-Induced Emission (AIE). Unlike conventional non-fullerene acceptors that suffer from aggregation-caused quenching (ACQ)—where tight packing leads to energy loss as heat—TPE-BTA3's geometry restricts internal motion when clustered, forcing energy emission as light. This results in a photoluminescence quantum yield (PLQY) of 68%.

The researchers employed a ternary strategy, adding TPE-BTA3 as a third component to a binary organic bulk-heterojunction. This configuration provided two primary technical advantages:

- **Voltage Increase:** The boosted PLQY of the alloy-acceptor system reduced non-radiative losses, lifting the open-circuit voltage.
- **Current Increase:** The molecule strengthened the absorption of near-infrared photons, increasing the short-circuit current.

The final tandem architecture pairs this optimized organic bottom cell with a wide-bandgap perovskite top cell operating at 1.85 eV.

Background & Context

Perovskite-organic tandem cells stack layers to capture a broader solar spectrum, but the organic layer often loses more voltage than theoretical limits suggest. This is caused by non-radiative recombination, where electrons and holes annihilate without producing current or light. While AIE materials have been used in bioimaging and sensing, their application in photovoltaics has remained largely unexplored until this conceptual shift.

Significance & Outlook

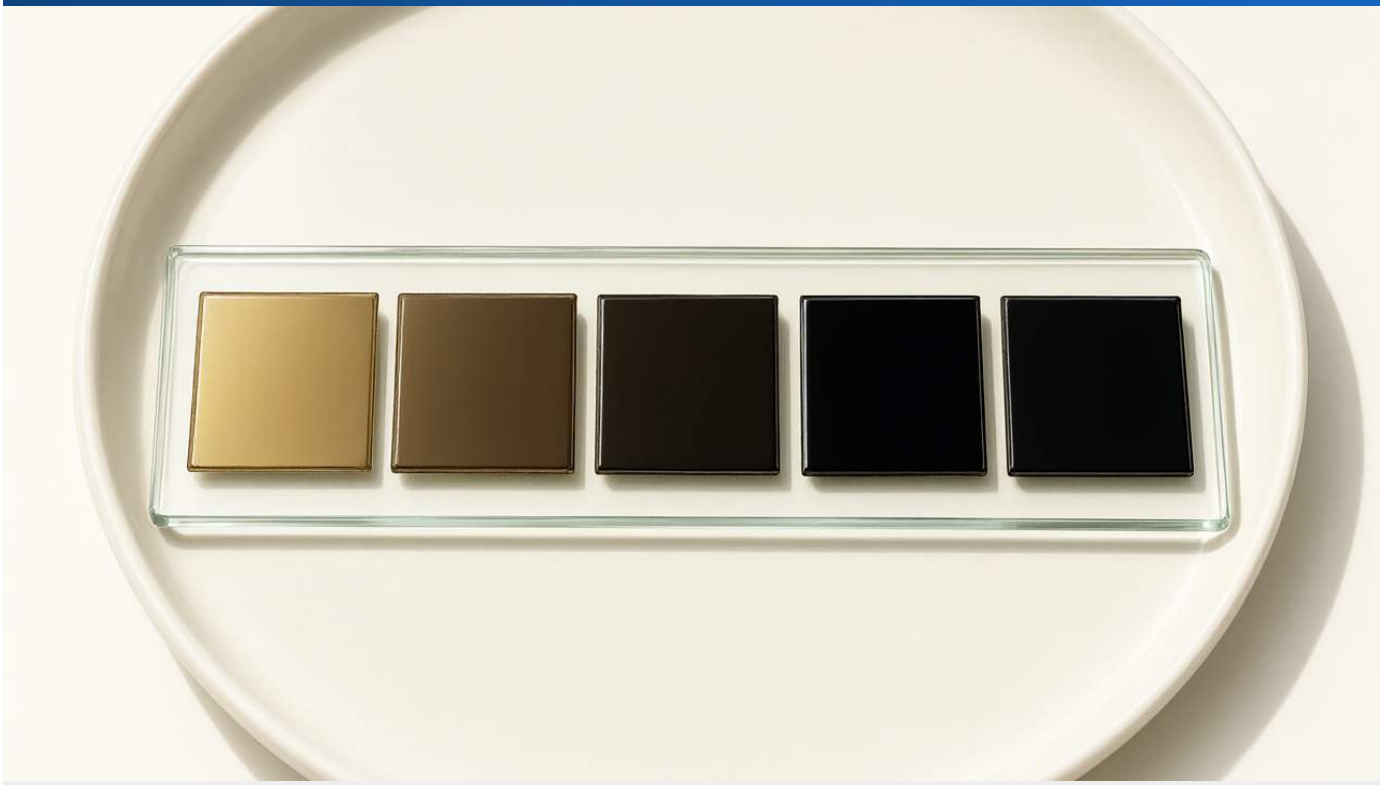
The success of TPE-BTA3 demonstrates that luminescence-focused molecular engineering can effectively mitigate energy losses in next-generation solar technologies. The primary remaining questions for the field are whether this AIE approach can be extended to other material systems, scaled up, and transitioned into manufacturable devices.

Source: https://energiesmedia.com/molecule-glows-clusters-solar-efficiency/

Collected: November 07, 2026 | Automated Research System (AI)

#12 Perovskite Solar Cells: PEAI Concentration for Efficiency and Stability

Published November 02, 2026 매일전북 (Maeil Jeonbuk) South Korea



OVERVIEW

Researchers from Kunsan National University have identified an optimal concentration of phenethylammonium iodide (PEAI) to enhance the efficiency and stability of triple-cation perovskite solar cells. Adding 0.50 wt% PEAI increased the maximum power conversion efficiency to 20.98% and significantly improved durability under high-temperature and high-humidity conditions.

IN DEPTH

Key Findings

The research team, led by Professors Yang Jung-yeop and Lee Yong-je of Kunsan National University in collaboration with Professor Park Ju-sang of Korea Polytechnic University Asan Campus, demonstrated that precise control of additive concentration is critical for optimizing perovskite solar cell performance. The most significant result was achieved with the addition of 0.50 wt% PEAI, which resulted in a maximum power conversion efficiency of 20.98%, compared to 18.33% for devices without the additive. The average efficiency across 20 devices also rose from 18.03% to 20.52%, confirming the reproducibility of the improvement.

Technical Details

The study utilized triple-cation perovskites consisting of cesium (Cs), formamidinium (FA), and methylammonium (MA). The team analyzed how varying concentrations of the organic additive PEAI affected crystal structure and electrical properties. Key technical improvements include:

- **Charge Carrier Dynamics:** The average lifetime of charge carriers generated by light increased approximately 2.2 times, from 94.53 nanoseconds (ns) to 206.46 ns.
- **Defect Reduction:** Trap density, which captures charges, decreased by approximately 33%, indicating the suppression of non-radiative recombination.
- **Structural Integrity:** Low concentrations of PEAI maintained the 3D perovskite crystal structure while reducing charge loss. Conversely, higher concentrations led to structural changes associated with the formation of low-dimensional crystal phases.

Environmental Stability

The devices were tested under extreme conditions of 85°C and 85% relative humidity. After 1,000 hours, the 0.50 wt% PEAI-added devices maintained approximately 57% of their initial efficiency. In contrast, the additive-free devices maintained only about 6% of their initial efficiency after 740 hours.

Significance and Outlook

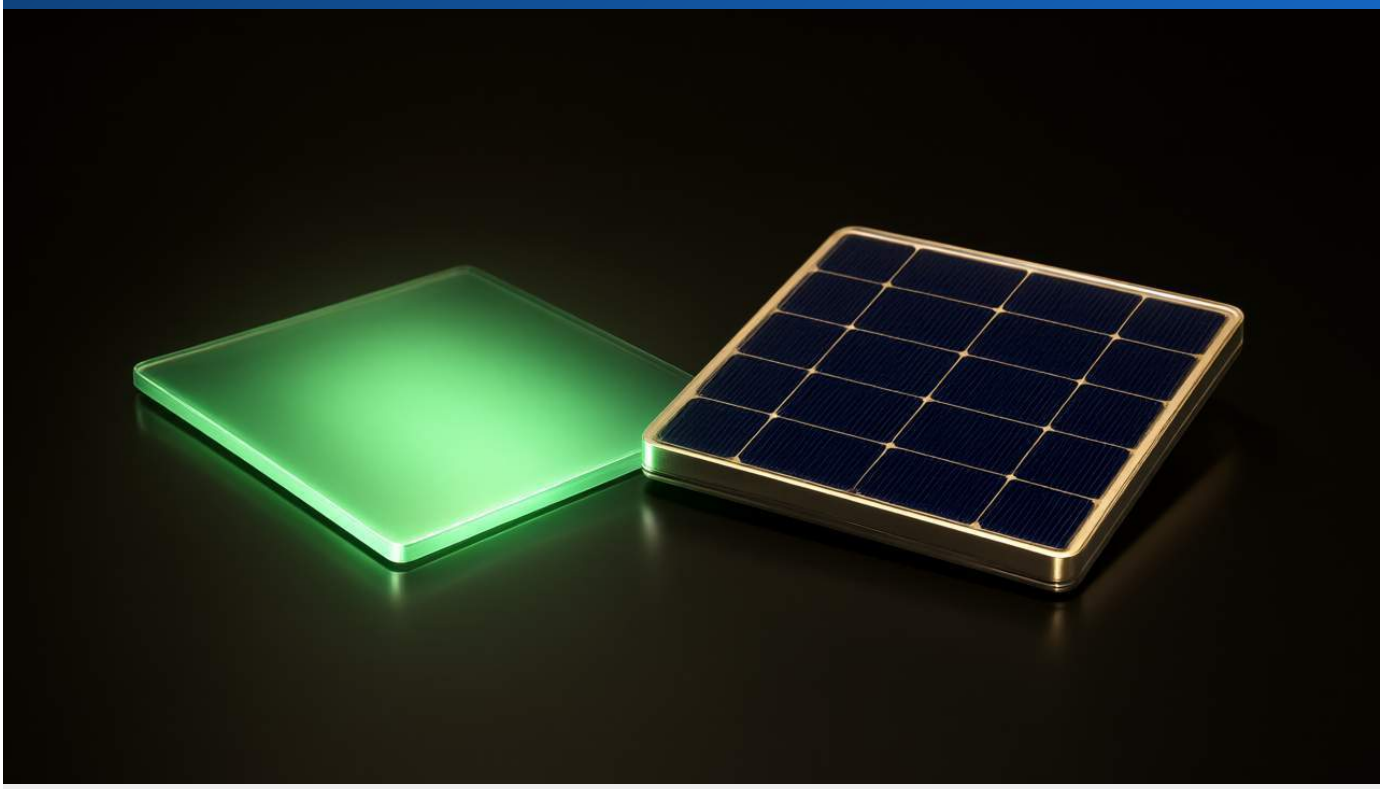
By optimizing PEAI concentration, the researchers successfully mitigated charge loss caused by defects within the material and at grain boundaries without compromising the 3D crystal structure. These findings, published in *Cell Reports Physical Science*, provide foundational data for material design and process optimization to develop high-efficiency, high-stability next-generation solar cells.

Source: http://www.mjeonbuk.com/news/articleView.html?idxno=149836

Collected: November 07, 2026 | Automated Research System (AI)

#13 Perovskite Thin Films: SKKU's Eutectic Engineering for Solar and LEDs

Published November 04, 2026 Newswise（成均館大学） South Korea



OVERVIEW

Researchers at Sungkyunkwan University (SKKU) have developed a low-defect perovskite semiconductor thin film using a volatile eutectic mixture. The process achieved a record-low surface recombination velocity of 0.3 cm/s, enabling both a 26.5% efficient solar cell and a 26.1% external quantum efficiency LED using the same material platform.

IN DEPTH

Key Findings

A research team led by Professor Seong Sik Shin of SKKU, in collaboration with KRICT, UC San Diego, and Princeton University, has produced perovskite semiconductor thin films with significantly reduced defects. The resulting films achieved a charge-carrier lifetime of approximately 295 μs and a surface recombination velocity of 0.3 cm/s, the lowest reported value for lead halide perovskites and comparable to passivated silicon. These films were used to create solar cells with a power conversion efficiency of 26.5% (certified 25.9%) and an open-circuit voltage of 1.208 V, as well as LEDs with an external quantum efficiency of 26.1%.

Technical Details

The team utilized "eutectic engineering" to address defects typically found at grain boundaries and surfaces during the solidification of liquid precursor solutions. The process involves combining methylammonium chloride (MACl) and a zinc halide (ZnX_2), two materials that, when mixed, have a lower melting temperature than their individual components.

- **Process:** Heating the film to approximately 100°C transforms the mixture at grain boundaries into a thin liquid layer.
- **Crystal Growth:** Atoms diffuse approximately 10,000 times faster in this liquid state, allowing small grains to merge into larger, cleaner crystals.
- **Post-Processing:** MACl evaporates during thermal annealing, while remaining zinc segregates toward grain boundaries to suppress defects.

Background & Context

Perovskites are valued for low manufacturing costs and simple processing for both light-to-electricity (solar) and electricity-to-light (LED) conversion. However, microscopic crystal grains often create defects that trap or eliminate photo-generated charge carriers, reducing device lifetime and performance.

Significance & Outlook

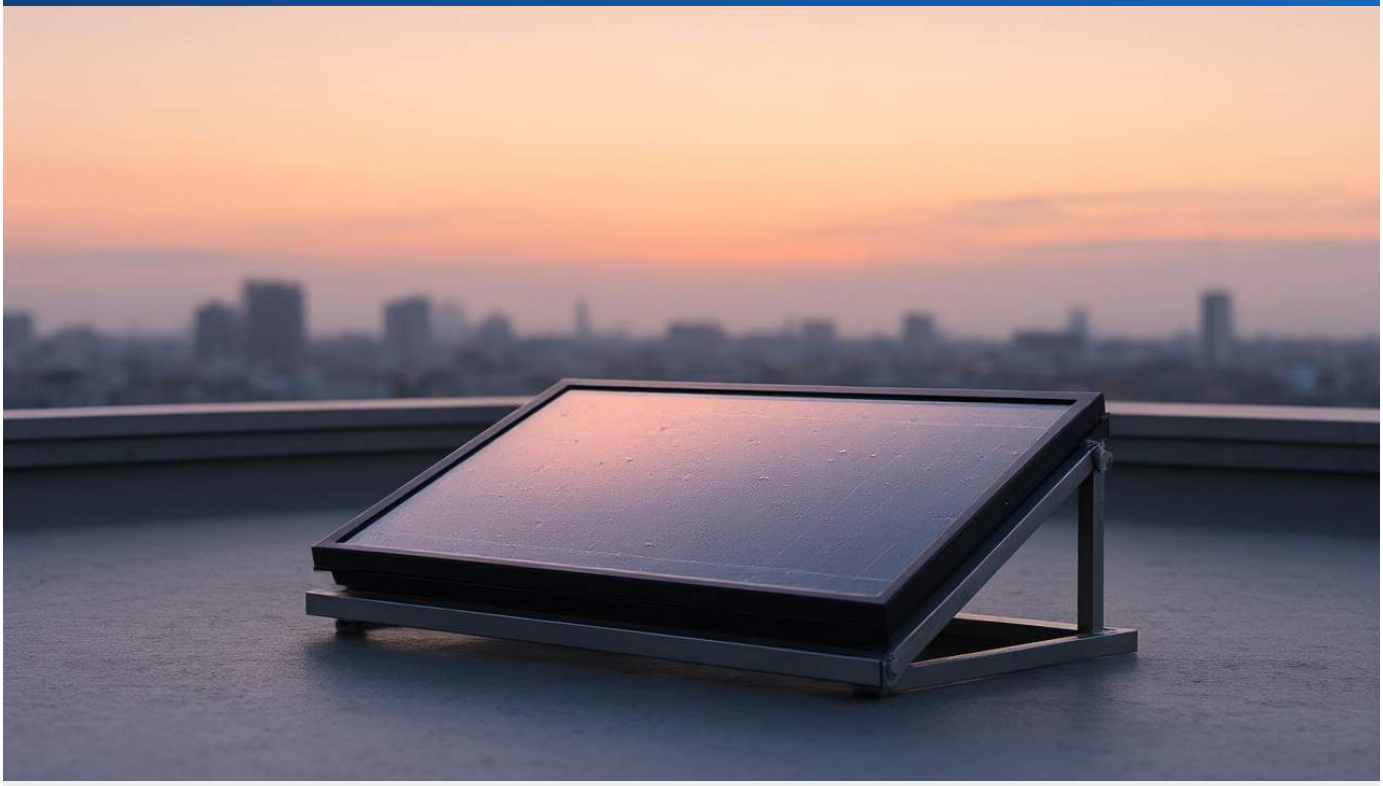
This method is the first to use a volatile eutectic mixture to fundamentally reduce perovskite defects without requiring expensive specialized equipment. Because the technology has demonstrated strong performance over large areas and works across a single device architecture for both power generation and light emission, the researchers expect it to accelerate the commercialization of perovskite solar cells and find applications in photodetectors and displays.

Source: https://www.newswise.com/articles/skku-develops-ultra-low-defect-semiconductor-thin-films-through-eutectic-engineering-enabling-both-solar-cells-and-leds

Collected: November 07, 2026 | Automated Research System (AI)

#14 Perovskite Mini-Modules: 23.9% Efficiency via Fill Factor Retention

Published November 06, 2026 Perovskite-Info



OVERVIEW

Researchers have achieved a certified steady-state efficiency of 23.9% in a 19.48 cm² perovskite mini-module by mitigating fill factor loss during scale-up. The team utilized a cryo-controlled processing step to reduce diode non-ideality, linking efficiency retention in larger devices to long-term operational stability.

IN DEPTH

Key Findings

A research collaboration involving Microquanta Semiconductor, Zhejiang University, China Three Gorges Renewable, the Australian Centre for Advanced Photovoltaics, and the Zhejiang Provincial Key Laboratory of Optoelectronic Functional Materials and Devices has developed a perovskite mini-module with a certified steady-state efficiency of 23.9%. The device, featuring an aperture area of 19.48 cm², achieved a fill factor of 83.3%.

Technical Details

The team analyzed the causes of efficiency degradation that occurs when transitioning from lab-scale devices to larger modules. Their analysis identified the fill factor as a primary contributor to this loss. To further isolate the cause, the researchers categorized the fill factor deficit into three specific contributions: voltage-related, transport-related, and diode-non-ideality.

To address these losses, the team implemented a cryo-controlled processing step. This method regulates the evolution of an intermediate phase during the crystallization process. According to the researchers, the resulting efficiency gains are primarily attributed to the reduction of diode non-ideality, while the other contributions remained smaller. Notably, the advantage provided by this processing step increases as the device size grows.

Background & Context

The study focuses on the "scale-up gap," where perovskite solar cells typically lose efficiency as they move from small-scale laboratory cells to larger modules. By identifying the specific mechanisms behind fill factor degradation, the team was able to apply a targeted processing solution to maintain performance across a larger surface area.

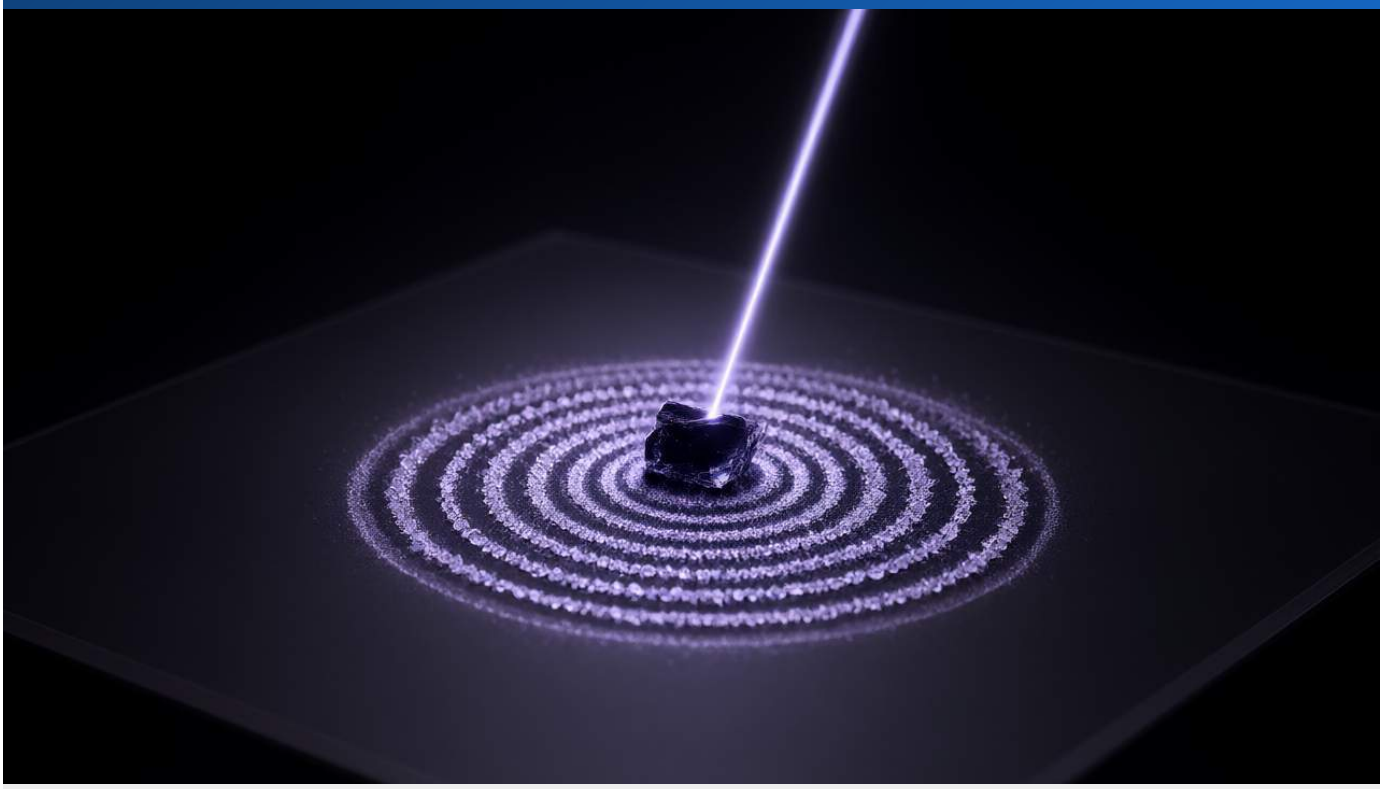
Significance & Outlook

Beyond immediate efficiency gains, the researchers indicate that the same fill factor limitations that hinder scale-up also govern performance decay during actual operation. This finding establishes a direct link between efficiency retention during the scaling process and the long-term stability of the solar cells, providing a potential pathway for improving the durability of commercial-scale perovskite modules.

Source: https://www.perovskite-info.com/fill-factor-retention-helps-perovskite-mini-module-reach-certified-239

#15 Perovskite Solar Cells: 26.5% Efficiency via Defect Reduction

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OVERVIEW

Researchers from Argonne National Laboratory, Sungkyunkwan University, and other institutions have developed a crystal growth technique that reduces defects in perovskite materials. This method achieved a 26.5% energy conversion efficiency in small-scale solar cells and demonstrated improved durability under high-temperature conditions.

IN DEPTH

Key Findings

A joint research team including the U.S. Department of Energy's Argonne National Laboratory, Sungkyunkwan University, and the Korea Research Institute of Chemical Technology has achieved an energy conversion efficiency of 26.5% for small-scale perovskite solar cells, with a certified measurement of 25.9%. The team also produced mini-modules exceeding 15㎠ with an efficiency of 23.9%. Beyond photovoltaics, the technology enabled a light conversion external quantum efficiency of 26.1% when applied to LEDs.

Technical Details

The researchers addressed the issue of microscopic defects that form during the crystallization of perovskite, which typically hinder charge transport and reduce lifespan. To mitigate this, the team utilized a "eutectic" phenomenon by mixing zinc bromide and methylammonium chloride, allowing the material to melt briefly at low temperatures and rearrange uniformly.

The crystal growth process follows four stages:

- **Starting material:** Zinc-containing additives are placed between small perovskite crystals.
- **Initial melting:** Heating triggers the eutectic effect, melting parts of the crystal boundaries.
- **Crystal growth:** Atoms rearrange, increasing crystal size and reducing internal defects.
- **Final solidification:** Volatile components evaporate, leaving a large, uniform crystal structure.

During heat treatment, methylammonium chloride evaporates while zinc gathers at the grain boundaries to reduce defects. This process was verified using the Advanced Photon Source (APS) X-ray nanoprobe at Argonne.

Background & Context

The study, published in the October 8 issue of *Science*, involved collaborations with Princeton University and UC San Diego. Perovskites are semiconductor materials capable of converting light to electricity and vice versa, making them suitable for solar cells, LEDs, displays, and optical sensors.

Significance & Outlook

The technology demonstrates significant durability; small cells maintained 85.8% of their initial efficiency after 1,400 hours of continuous operation at 85°C. While these results suggest a path toward large-area manufacturing, the researchers note that laboratory performance does not guarantee mass-production yields or long-term stability in outdoor environments. Further verification of manufacturing reproducibility and environmental stability is required for commercialization.

Source: https://www.esnews.kr/news/articleView.html?idxno=7136

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