

TROY TECHNICAL

PEROVSKITE SOLAR CELLS

WEEKLY REPORT

October 10 - October 16, 2026 | Issue 2026-W41

**Bankable module performance, durability,
manufacturing yield and market entry**

14

ANALYZED ARTICLES

10

PRIORITY THEMES

Issued 2026-10-16 | English edition | fixed approved cover artwork



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

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

SIGNAL 01 | BUSINESS / RULES

Perovskite-Silicon Tandems: 29.1% Efficiency via SAM Optimization

Primary-source report: Researchers have achieved a certified 29.1% conversion efficiency in perovskite-silicon tandem solar cells by optimizing the acidity of self-assembled monolayer (SAM) solutions.

SIGNAL 02 | SYSTEM / ADOPTION

Perovskite Solar Cells: Defect Reduction via Chemical Mixtures

Primary-source report: Researchers at Princeton Engineering and partner institutions have reduced atomic-level defects in perovskite crystals by adding a combination of zinc bromide and methyl ammonium chloride.

SIGNAL 03 | SYSTEM / ADOPTION

Inverted Perovskite Solar Cells: High-Entropy Contacts Reach 27.5% Efficiency

Collected report (not independently verified): Researchers in China have achieved a power conversion efficiency (PCE) of 27.50% in inverted perovskite solar cells by implementing high-entropy molecular contacts (HE-MCs).

SIGNAL 04 | TECH / PROCESS

Perovskite Solar Submodules: UNSW and UtmoLight Record 23.5% Efficiency

Collected report (not independently verified): Researchers from UNSW Sydney and UtmoLight have achieved a world-record certified stabilized power conversion efficiency of 23.5% for a large-area perovskite solar submodule.

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

29.1% A06	SOURCE-BOUND CONDITION SAM-optimized tandem; certified PCE
10x A14	SOURCE-BOUND CONDITION Princeton electron energy-retention time
27.50% A07	SOURCE-BOUND CONDITION Inverted cell; high-entropy contacts
23.5% A08	SOURCE-BOUND CONDITION Large-area submodule; certified stable PCE
OPEN A06	SOURCE-BOUND CONDITION Application-specific damp-heat and light stability, reproducibility and deployment terms remain unproven. Published claims are not customer-qualified performance.

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
Primary-source report: Researchers have achieved a certified 29.1% conversion efficiency in perovskite-silicon tandem solar cells by optimizing the acidity of self-assembled monolayer (SAM) solutions.

2

Cell stack
P02/P07
Primary-source report: Researchers at Princeton Engineering and partner institutions have reduced atomic-level defects in perovskite crystals by adding a combination of zinc bromide and methyl ammonium chloride.

3

Module process
P03/P08
Collected report (not independently verified): Researchers in China have achieved a power conversion efficiency (PCE) of 27.50% in inverted perovskite solar cells by implementing high-entropy molecular contacts (HE-MCs).

4

Qualification
P04/P09
Collected report (not independently verified): Researchers from UNSW Sydney and UtmoLight have achieved a world-record certified stabilized power conversion efficiency of 23.5% for a large-area perovskite solar submodule.

5

Deployment & recycling
P05/P10
Collected report (not independently verified): Researchers have achieved a certified power conversion efficiency of 25.9% in perovskite solar cells by introducing a temporary liquid phase during crystallization.

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



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.

For legibility, scores of 18 or below use an 18-pt bubble diameter; underlying scores are unchanged.

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

P01

Perovskite-Silicon Tandems: 29.1% Efficiency via SAM Optimization

A06 | Business / rules | Prototype

2026-10-15

FACT

Primary-source report: Researchers have achieved a certified 29.1% conversion efficiency in perovskite-silicon tandem solar cells by optimizing the acidity of self-assembled monolayer (SAM) solutions. This molecular adjustment prevents aggregation, enhancing both charge transport and long-term stability to meet international IEC61215 standards.

WHY IT MATTERS

In practical terms, Perovskite-Silicon Tandems needs separate tests of certified efficiency and area and damp-heat and light stability before the result becomes an adoption case.

BUSINESS READ

For Perovskite-Silicon Tandems, compare certified efficiency and area and damp-heat and light stability under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite-Silicon Tandems on certified efficiency and area against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific damp-heat and light stability, reproducibility and deployment terms remain unproven. Published claims are not customer-qualified performance.

EDITORIAL SCORE 17/25 | MATURITY 2/5 | DECISION LOCUS: BUSINESS / RULES

P02

Perovskite Solar Cells: Defect Reduction via Chemical Mixtures

A14 | System / adoption | Prototype

2026-10-13

FACT

Primary-source report: Researchers at Princeton Engineering and partner institutions have reduced atomic-level defects in perovskite crystals by adding a combination of zinc bromide and methyl ammonium chloride. This technique allows electrons to retain energy 10 times longer than untreated perovskites, potentially increasing power generation by 1% in cutting-edge cells.

WHY IT MATTERS

In practical terms, Perovskite Solar Cells needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For Perovskite Solar Cells, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite Solar Cells on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Published claims are not customer-qualified performance.

EDITORIAL SCORE 17/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

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

P03

Inverted Perovskite Solar Cells: High-Entropy Contacts Reach 27.5% Efficiency

A07 | System / adoption | Prototype

2026-10-13

FACT

Collected report (not independently verified): Researchers in China have achieved a power conversion efficiency (PCE) of 27.50% in inverted perovskite solar cells by implementing high-entropy molecular contacts (HE-MCs). This three-molecule blend prevents the collapse of molecular packing under thermal stress, significantly enhancing both operational stability and device performance.

WHY IT MATTERS

In practical terms, Inverted Perovskite Solar Cells needs separate tests of substance and jurisdiction and assay and effective date before the result becomes an adoption case.

BUSINESS READ

For Inverted Perovskite Solar Cells, compare substance and jurisdiction and assay and effective date under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Inverted Perovskite Solar Cells on substance and jurisdiction against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific assay and effective date, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

P04

Perovskite Solar Submodules: UNSW and UtmoLight Record 23.5% Efficiency

A08 | Tech / process | Prototype

2026-10-13

FACT

Collected report (not independently verified): Researchers from UNSW Sydney and UtmoLight have achieved a world-record certified stabilized power conversion efficiency of 23.5% for a large-area perovskite solar submodule. This benchmark narrows the gap between large-scale modules and small-area laboratory cells, demonstrating the scalability of high-efficiency perovskite manufacturing.

WHY IT MATTERS

In practical terms, Perovskite Solar Submodules needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For Perovskite Solar Submodules, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite Solar Submodules on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

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

P05

Perovskite Solar Cells: 25.9% Efficiency via Eutectic Liquid Stage

A04 | Tech / process | Prototype

2026-10-11

FACT

Collected report (not independently verified): Researchers have achieved a certified power conversion efficiency of 25.9% in perovskite solar cells by introducing a temporary liquid phase during crystallization. This method reduces grain boundary defects, enabling high performance in both small-area cells and larger minimodules.

WHY IT MATTERS

In practical terms, Perovskite Solar Cells needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For Perovskite Solar Cells, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite Solar Cells on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P06

Perovskite-Silicon Tandem Cells: 32.3% Efficiency via Electrode Redesign

A10 | Business / rules | Prototype

2026-10-14

FACT

Collected report (not independently verified): Researchers have achieved a certified efficiency of 32.28% (champion efficiency of 33.06%) for perovskite-silicon tandem solar cells by optimizing the front electrode. The improvement stems from replacing standard transparent conductive oxides with tungsten-doped indium oxide (IWO) and optimizing metal grid geometry.

WHY IT MATTERS

In practical terms, Perovskite-Silicon Tandem Cells needs separate tests of certified efficiency and area and damp-heat and light stability before the result becomes an adoption case.

BUSINESS READ

For Perovskite-Silicon Tandem Cells, compare certified efficiency and area and damp-heat and light stability under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite-Silicon Tandem Cells on certified efficiency and area against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific damp-heat and light stability, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: BUSINESS / RULES

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

P07

Perovskite Solar Cells: ITO Oxygen Leakage and Stability Fix

A03 | Tech / process | Prototype

2026-10-13

FACT

Collected report (not independently verified): Researchers have discovered that indium tin oxide (ITO) substrates leak oxygen into perovskite layers at elevated temperatures, accelerating device degradation. By implementing a self-assembled monolayer as a diffusion barrier, the team successfully mitigated this internal contamination.

WHY IT MATTERS

In practical terms, Perovskite Solar Cells needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For Perovskite Solar Cells, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite Solar Cells on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 14/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P08

China PV Export Controls: Perovskite and Tandem Tech Restrictions 2026

A09 | Tech / process | Product adoption

2026-10-16

FACT

Collected report (not independently verified): China's Ministry of Commerce (Mofcom) and Ministry of Industry and Information Technology (MIIT) have proposed banning the export of high-efficiency perovskite and tandem solar manufacturing technologies. The proposal targets specific production processes and equipment, potentially limiting international access to next-generation PV manufacturing know-how.

WHY IT MATTERS

In practical terms, China PV Export Controls needs separate tests of duty-cycle aging and temperature-dependent efficiency before the result becomes an adoption case.

BUSINESS READ

For China PV Export Controls, compare duty-cycle aging and temperature-dependent efficiency under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare China PV Export Controls on duty-cycle aging against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific temperature-dependent efficiency, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 17/25 | MATURITY 4/5 | DECISION LOCUS: TECH / PROCESS

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

P09

Perovskite Solar Cells: UV Stability and Outdoor Degradation 2024

A13 | System / adoption | Prototype

2026-10-16

FACT

Collected report (not independently verified): Researchers have developed a hybrid polymer hole-transport layer that reduces ultraviolet degradation in perovskite solar cells (PSCs). A champion module maintained over 16% operational efficiency after 29 weeks of outdoor testing, bridging the gap between laboratory and real-world durability.

WHY IT MATTERS

In practical terms, Perovskite Solar Cells needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For Perovskite Solar Cells, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare Perovskite Solar Cells on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

P10

(NDI-dH)2AgBiI8: Lead-Free Perovskite Photoanode for Water Use

A11 | Tech / process | Prototype

2026-10-11

FACT

Collected report (not independently verified): Researchers at EPFL's LIMNO lab have developed a lead-free layered double perovskite, (NDI-dH)2AgBiI8, capable of operating as a photoanode in water. By utilizing a water-repelling naphthalene diimide spacer, the material achieves higher carrier mobility and stability compared to aliphatic or benzene-based alternatives.

WHY IT MATTERS

In practical terms, (NDI-dH)2AgBiI8 needs separate tests of defects and film quality and outdoor degradation before the result becomes an adoption case.

BUSINESS READ

For (NDI-dH)2AgBiI8, compare defects and film quality and outdoor degradation under the same application conditions. Request source protocols before extrapolating to customer use. This is an editorial inference.

ACTION

Within 30 days, R&D and quality should compare (NDI-dH)2AgBiI8 on defects and film quality against a baseline; deliver an acceptance and stop-rule sheet.

UNKNOWN

Application-specific outdoor degradation, reproducibility and deployment terms remain unproven. Confirm the original primary record.

EDITORIAL SCORE 15/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

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 01-14

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	Cs2PdBr6 Perovskite Solar Cells: Band Alignment for 27% Efficiency	https://bioengineer.org/band-alignment-trick-pushes-lead-free-perovskite-solar-cells-toward-27-efficiency/
A02	Solar Panel Technology 2026: Efficiency Records and Roadmap	https://www.greenlancer.com/post/solar-panel-technology-trends
A03	Perovskite Solar Cells: ITO Oxygen Leakage and Stability Fix	https://bioengineer.org/hidden-oxygen-leaks-from-solar-cell-substrates-and-slowly-tears-perovskites-apart/
A04	Perovskite Solar Cells: 25.9% Efficiency via Eutectic Liquid Stage	https://www.perovskite-info.com/perovskite-solar-cells-reach-259-efficiency-short-lived-liquid-stage
A05	Perovskite Solar Cells: Yunnan University's 10-Metre Depth Specs	https://trekzone.org/2026/10/new-yunnan-university-perovskite-solar-cells-successfully-operate-at-10-metre-ocean-depths/
A06	Perovskite-Silicon Tandems: 29.1% Efficiency via SAM Optimization	https://micro.org.au/news/molecular-makeover-boosts-solar-performance/
A07	Inverted Perovskite Solar Cells: High-Entropy Contacts Reach 27.5% Efficiency	https://www.pv-magazine.com/2026/10/13/three-molecule-blend-boosts-inverted-perovskite-solar-cell-efficiency-to-27-5/
A08	Perovskite Solar Submodules: UNSW and UtmoLight Record 23.5% Efficiency	https://www.mercomindia.com/australian-researchers-claim-record-perovskite-submodule-efficiency
A09	China PV Export Controls: Perovskite and Tandem Tech Restrictions 2026	https://pv-magazine-usa.com/2026/10/16/china-proposes-ban-on-exports-of-perovskite-tandem-solar-manufacturing-technology/
A10	Perovskite-Silicon Tandem Cells: 32.3% Efficiency via Electrode Redesign	https://www.perovskite-info.com/electrode-redesign-pushes-perovskite-silicon-tandem-solar-cells-323-certified
A11	(NDI-dH)2AgBiI8: Lead-Free Perovskite Photoanode for Water Use	https://www.perovskite-info.com/water-repelling-spacer-lets-lead-free-perovskite-work-photoanode-water
A12	Solvent-Free Tandem Solar Cells: Industrial Scalability and Specs	https://wsset.org/news/how-do-solvent-free-tandem-solar-cells-boost-clean-energy-scalability/
A13	Perovskite Solar Cells: UV Stability and Outdoor Degradation 2024	https://optics.org/news/nrel-examines-degradation-mechanisms-of-perovskite-solar-cells
A14	Perovskite Solar Cells: Defect Reduction via Chemical Mixtures	https://engineering.princeton.edu/news/2026/10/13/building-better-solar-tech-crystal-time

Scope: retrieving a source does not independently validate performance, cost or clinical utility. The claim ledger distinguishes announcements, papers and secondary reporting. Material published before the reporting week is continuing context, not a new event. Editorial inferences and actions are not investment or medical advice.

PerovskiteSolarCells — Selected Articles

Date: 2026-10-18

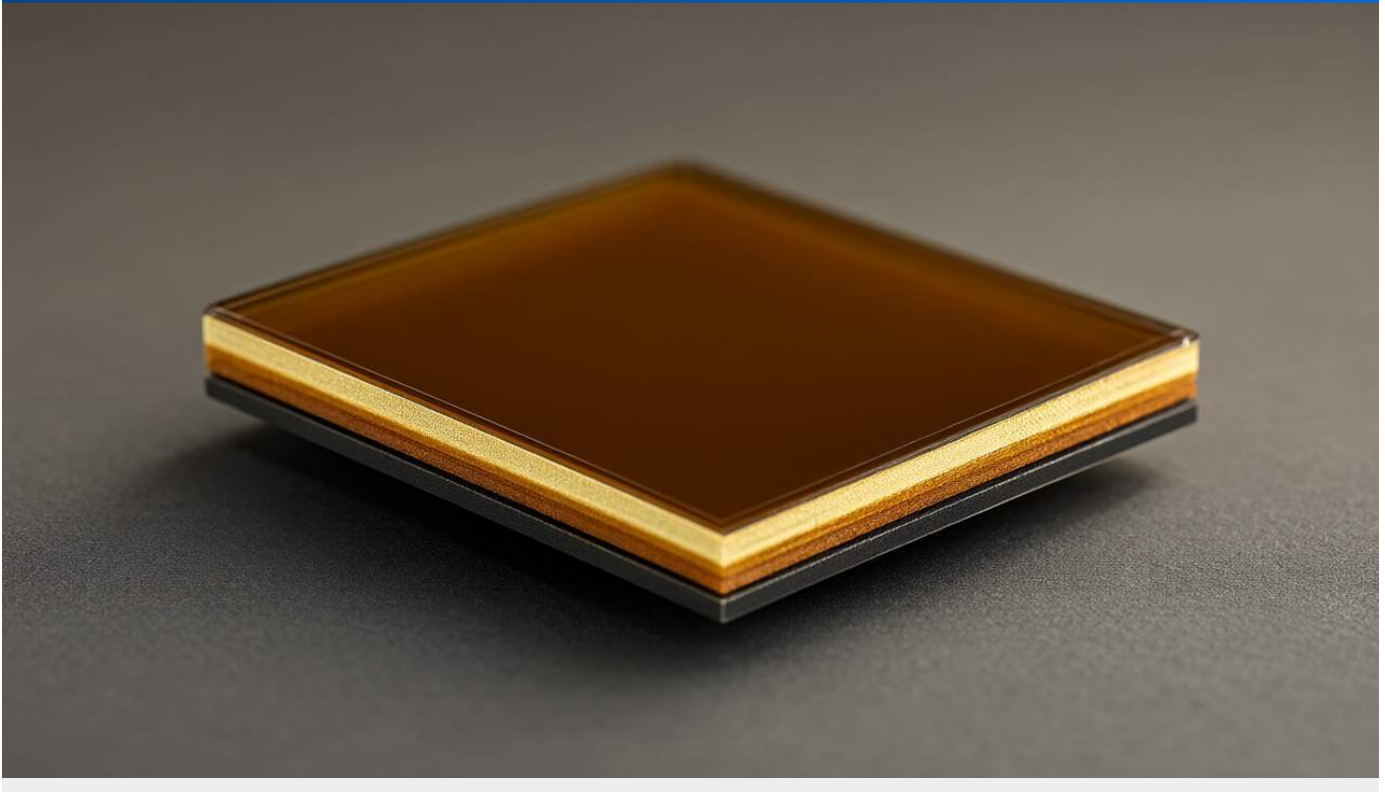
Articles: 14

Table of Contents

- #01 Cs₂PdBr₆ Perovskite Solar Cells: Band Alignment for 27% Efficiency
- #02 Solar Panel Technology 2026: Efficiency Records and Roadmap
- #03 Perovskite Solar Cells: ITO Oxygen Leakage and Stability Fix
- #04 Perovskite Solar Cells: 25.9% Efficiency via Eutectic Liquid Stage
- #05 Perovskite Solar Cells: Yunnan University's 10-Metre Depth Specs
- #06 Perovskite-Silicon Tandems: 29.1% Efficiency via SAM Optimization
- #07 Inverted Perovskite Solar Cells: High-Entropy Contacts Reach 27.5% Efficiency
- #08 Perovskite Solar Submodules: UNSW and UtmoLight Record 23.5% Efficiency
- #09 China PV Export Controls: Perovskite and Tandem Tech Restrictions 2026
- #10 Perovskite-Silicon Tandem Cells: 32.3% Efficiency via Electrode Redesign
- #11 (NDI-dH)₂AgBi: Lead-Free Perovskite Photoanode for Water Use
- #12 Solvent-Free Tandem Solar Cells: Industrial Scalability and Specs
- #13 Perovskite Solar Cells: UV Stability and Outdoor Degradation 2024
- #14 Perovskite Solar Cells: Defect Reduction via Chemical Mixtures

#01 Cs₂PdBr₆ Perovskite Solar Cells: Band Alignment for 27% Efficiency

Published October 13, 2026 BIOENGINEER.ORG India



OVERVIEW

Computational research indicates that optimizing the valence band offset (VBO) in lead-free Cs₂PdBr₆ perovskite solar cells can push power conversion efficiency to 27.48%. By utilizing vanadium pentoxide (V₂O₅) as a hole transport layer, researchers achieved a balanced "spike" alignment that minimizes recombination and maximizes carrier extraction.

Key Findings

A numerical study by researchers at the Maulana Azad National Institute of Technology indicates that a lead-free, all-inorganic perovskite solar cell using Cs₂PdBr₆ can reach a power conversion efficiency of 27.48%. This result was achieved by optimizing the interface between the absorber and the hole transport layer. The simulated device utilizing vanadium pentoxide (V₂O₅) demonstrated an open-circuit voltage of 1.26 volts, a short-circuit current density of 25.1 milliamperes per square centimetre, and a fill factor of 87.3 percent.

Technical Details

The research focused on the valence band offset (VBO), the energy difference between the valence band edge of the hole transport layer and the absorber. Using the SCAPS-1D simulator, the team analyzed three alignment regimes:

- **Cliff-type:** Occurs when the absorber's valence band sits above the transport layer's. This leads to weak interfacial electric fields and increased interfacial recombination.
- **Excessive Spike-type:** Occurs when the offset is too large, creating a transport barrier that causes carrier accumulation at the interface.
- **Optimized Spike-type:** A balanced positive VBO that generates an optimized depletion field, assisting the drift transport of holes while suppressing recombination.

V₂O₅ was identified as the optimal material, providing a valence band offset of plus 0.3 electron volts relative to the Cs₂PdBr₆ absorber. Quantum efficiency analysis showed that this alignment enhances long-wavelength carrier collection by extending the effective drift region across the bulk of the absorber.

Background & Context

Conventional lead-halide perovskites face challenges regarding toxicity and the volatility of organic components. Cs₂PdBr₆ is an all-inorganic, lead-free alternative that eliminates these specific commercialization hurdles. However, the material requires precise energetic alignment with selective contacts to translate its optoelectronic properties into practical efficiency.

Significance & Outlook

The study shifts the design focus from the absorber's internal composition to the interface energetics. By treating the VBO as a primary design variable, the researchers have demonstrated a hypothetical device that performs within the range of the best experimentally reported lead-based perovskite cells.

Source: <https://bioengineer.org/band-alignment-trick-pushes-lead-free-perovskite-solar-cells-toward-27-efficiency/>

Collected: October 17, 2026 | Automated Research System (AI)

#02 Solar Panel Technology 2026: Efficiency Records and Roadmap

Published October 12, 2026 GreenLancer USA



OVERVIEW

Perovskite-silicon tandem cells have reached a certified efficiency record of 35.5% as of July 2026. While commercial residential panels typically range between 20% and 23%, the emergence of back contact and TOPCon technologies is pushing commercial limits toward 25%. These advancements are expanding the versatility of solar deployment across residential, commercial, and utility-scale projects.

Key Findings

The most significant breakthrough in 2026 is the achievement of a 35.5% efficiency record for perovskite-silicon tandem cells, certified by the European Solar Test Installation in July 2026. This record, set by LONGi, surpasses the previous 34.85% mark certified in April 2025 by the National Laboratory of the Rockies. For conventional single-junction silicon, LONGi raised the efficiency record to 28.29% in September 2026.

Technical Details

Current solar cell technologies are categorized by their architecture and market availability:

- **TOPCon:** A passivated contact cell utilizing an ultrathin tunnel oxide layer; it remained the leading cell technology in 2025 according to the 2026 ITRPV industry roadmap.
- **Heterojunction (HJT):** A cell that wraps a crystalline wafer in thin amorphous silicon layers, often used in premium panels.
- **Back Contact (TBC, HBC/HIBC, IBC):** An architecture moving electrical contacts to the rear to reduce shading. LONGi's mass-produced back contact modules now reach 25% efficiency, with lab-tested modules reaching 26.4%.

While research cells achieve high peaks, commercial modules score lower due to wiring, glass, and mass-production tolerances. Most residential panels in 2026 operate between 20% and 23% efficiency.

Background and Context

Long-term field performance remains a critical metric. Data from the National Laboratory of the Rockies shows that thin-film modules installed in 1995 by First Solar's predecessor retained approximately 88% of their original performance after 25 years, with an average annual degradation of 0.5%.

Significance and Outlook

The market is currently divided by technology readiness. TOPCon, HJT, bifacial panels, and thin-film CdTe for utility projects are widely available. Perovskite-silicon tandem panels and flexible solar for electronics are emerging through pilot shipments and limited utility-scale use. Transparent solar windows, ultralight fabric cells, and space-based solar remain in the experimental stage. While the perovskite revolution is underway, widespread residential availability is expected to take several more years.

Source: <https://www.greenlancer.com/post/solar-panel-technology-trends>

Collected: October 17, 2026 | Automated Research System (AI)

#03 Perovskite Solar Cells: ITO Oxygen Leakage and Stability Fix

Published October 13, 2026 Scienmag (News Source: Beatrice Stafford) USA



OVERVIEW

Researchers have discovered that indium tin oxide (ITO) substrates leak oxygen into perovskite layers at elevated temperatures, accelerating device degradation. By implementing a self-assembled monolayer as a diffusion barrier, the team successfully mitigated this internal contamination.

Key Findings

A study published in Communications Engineering reveals that the transparent electrode substrate, specifically indium tin oxide (ITO), acts as a source of extrinsic contaminants that degrade perovskite solar cells. While researchers previously attributed performance decay to volatile organic components and halide ions within the perovskite itself, this research demonstrates that oxygen leaks from the ITO substrate into the device when temperatures rise, accumulating at the buried interface and disrupting electrical contact quality.

Technical Details

To track atomic-scale migration, the team from the University of North Texas Ion Beam Laboratory and Arizona State University used Rutherford Backscattering Spectrometry (RBS). The experiment involved depositing methylammonium lead triiodide thin films on ITO-coated glass and thermally aging them at 45, 65, and 85 degrees Celsius for 96 hours under a nitrogen atmosphere.

- **Observation:** RBS measurements showed that lead and iodine redistributed during aging, but unexpectedly, oxygen piled up at the perovskite-electrode interface.
- **Verification:** Non-annealed control samples showed no such accumulation, while aged samples showed measurable oxygen loss and surface roughening of the ITO substrate, confirming thermally activated out-diffusion.
- **Mitigation:** The researchers inserted a self-assembled monolayer of [2-(3,6-Dimethoxy-9H-carbazol-9-yl) ethyl] phosphonic acid between the ITO and the perovskite to act as an interfacial diffusion barrier.

Background & Context

Perovskite solar cells are noted for high efficiency and cheap solution processing, but they suffer from instability when exposed to heat. ITO is the standard transparent electrode for thin-film photovoltaics due to its conductivity and transparency. However, this study proves that ITO is not an inert component; its oxygen sublattice serves as a reservoir of mobile species at elevated temperatures.

Significance & Outlook

This discovery reframes the problem of front-contact breakdown in perovskite devices. By identifying the substrate as an active participant in device decline, engineers can now focus on interfacial barriers to prevent oxygen migration, which otherwise disrupts band alignment and accelerates degradation pathways.

Source: <https://bioengineer.org/hidden-oxygen-leaks-from-solar-cell-substrates-and-slowly-tears-perovskites-apart/>

Collected: October 17, 2026 | Automated Research System (AI)

#04 Perovskite Solar Cells: 25.9% Efficiency via Eutectic Liquid Stage

Published October 11, 2026 Perovskite-Info USA



OVERVIEW

Researchers have achieved a certified power conversion efficiency of 25.9% in perovskite solar cells by introducing a temporary liquid phase during crystallization. This method reduces grain boundary defects, enabling high performance in both small-area cells and larger minimodules.

Key Findings

A collaborative research team has developed a method to enhance perovskite film quality, resulting in solar cells with a certified power conversion efficiency (PCE) of 25.9% (reaching 26.5% in some instances). The approach also proved effective for larger-scale devices, with perovskite minimodules exceeding 15 square centimeters achieving 23.9% efficiency. Additionally, the technique was applied to perovskite light-emitting diodes, which reached an external quantum efficiency of 26.1%.

Technical Details

The team improved film growth by adding a eutectic mixture of zinc bromide and methylammonium chloride to the perovskite ink. This mixture melts at a lower temperature than its individual components. During the annealing process, the eutectic locally melts around grain boundaries, allowing crystals to rearrange into a more orderly structure. Nanoprobe X-ray microscopy was used to observe this process.

The chemical dynamics during annealing are as follows:

- Methylammonium chloride evaporates from the film.
- Zinc remains at the interfaces and grain boundaries to passivate defects.
- The distribution of halides across the film is leveled.

The resulting films exhibited low surface recombination velocity, long charge carrier decay times, and high photoluminescence quantum yield.

Stability and Versatility

Stability tests on small-area cells utilizing a poly[bis(4-phenyl)(2,4,6-trimethylphenyl)amine] (PTAA) hole transport layer showed that the devices retained 85.8% of their initial 24.1% efficiency after 1,400 hours of continuous operation at 85°C. The researchers confirmed that this eutectic approach is compatible across various perovskite compositions.

Significance and Outlook

By removing performance-limiting defects at the edges of crystalline grains, this method addresses a primary bottleneck in perovskite performance, particularly for larger devices. The research involved a wide consortium including the University of California San Diego, Sungkyunkwan University, Princeton University, and nine other institutions. The team is currently investigating other eutectic chemistries to further optimize performance.

Source: <https://www.perovskite-info.com/perovskite-solar-cells-reach-259-efficiency-short-lived-liquid-stage>

Collected: October 17, 2026 | Automated Research System (AI)

#05 Perovskite Solar Cells: Yunnan University's 10-Metre Depth Specs

Published October 09, 2026 Trekzone Media China



OVERVIEW

Researchers at Yunnan University have developed perovskite solar cells capable of operating at ocean depths of up to 10 metres, five times deeper than previous technology. These cells enable long-term power for submerged sensors and communications gear without requiring battery swaps.

Key Findings

Yunnan University researchers have successfully validated the operation of perovskite solar cells at a depth of 10 metres. In field tests conducted near the Weizhou Islands in the South China Sea, large-area modules integrated with underwater robots generated 324 megawatt-hours of energy over a two-hour period. This energy output is sufficient to charge lithium-ion batteries, and data suggests the cells could operate continuously at this depth for approximately 5.5 years.

Technical Details

The technology utilizes a wide-bandgap perovskite structure specifically engineered to capture blue-to-orange wavelengths. This design addresses the physical limitation of seawater, which absorbs the warmer red end of the light spectrum at depth. To validate the cells, Wen-Hua Zhang and the research team used a customized laboratory system with optical filters to simulate various underwater lighting conditions.

- **Stability:** Cells retained approximately 96 per cent of initial efficiency after 300 days of storage in an oxygen-free environment.
- **Durability:** Minimal degradation was observed after 1,160 hours under simulated 10-metre depth conditions.

Background and Context

According to the study published in the journal *Joule*, existing underwater solar cells have generally been limited to depths of two metres or less. This limitation has restricted the deployment of autonomous submerged equipment, such as cameras and sensors, far from shore due to the necessity of frequent battery replacements.

Significance and Outlook

This development represents the first functional validation of underwater solar cells at practical operating depths. By providing a low-maintenance power source, the technology opens potential for long-term marine environment monitoring. Future research will focus on determining the maximum operating depth of the cells and establishing standardized testing protocols for underwater photovoltaic devices.

Source: <https://trekzone.org/2026/10/new-yunnan-university-perovskite-solar-cells-successfully-operate-at-10-metre-ocean-depths/>

Collected: October 17, 2026 | Automated Research System (AI)

#06 Perovskite-Silicon Tandems: 29.1% Efficiency via SAM Optimization

Published October 15, 2026 Microscopy Australia Australia



OVERVIEW

Researchers have achieved a certified 29.1% conversion efficiency in perovskite-silicon tandem solar cells by optimizing the acidity of self-assembled monolayer (SAM) solutions. This molecular adjustment prevents aggregation, enhancing both charge transport and long-term stability to meet international IEC61215 standards.

Key Findings

A research team led by Prof. Anita Ho-Baillie from the University of Sydney has developed a perovskite-silicon tandem solar cell with a certified conversion efficiency of 29.1%. The team successfully improved device stability, with cells retaining $\geq 95\%$ of their efficiencies after more than 1,000 thermal cycles and 26 humidity freeze cycles, exceeding the minimum requirements of the international IEC61215 standard.

Technical Details

The performance gains were achieved by addressing defects in the ultra-thin molecular layers used at microscopic interfaces. Specifically, the team focused on self-assembled monolayers (SAM), which typically suffer from molecules clumping together in solution, resulting in patchy coverage and energy losses.

- **Chemical Optimization:** The researchers identified the acidity of the SAM solution as the critical factor controlling molecular dispersion. By using a newly designed molecule to adjust acidity, they prevented aggregation and created a uniform molecular layer.
- **Analysis:** Ultraviolet photoelectron spectroscopy was employed to measure electronic energy levels at the interface. This provided evidence that the chemical adjustment improved energy alignment and transport, facilitating more efficient charge flow.
- **Infrastructure:** The project utilized advanced microanalysis from Adelaide Microscopy (part of Microscopy Australia) and fabrication support from the Australian National Fabrication Facility (ANFF), enabled by the National Collaborative Research Infrastructure Strategy (NCRIS).

Background & Context

Perovskite-silicon tandem cells stack two light-absorbing materials tuned to different parts of the solar spectrum to exceed the efficiency of conventional silicon cells. However, transitioning this technology from the lab to commercial use has been hindered by the difficulty of forming reliable, even molecular layers at the device interfaces.

Significance & Outlook

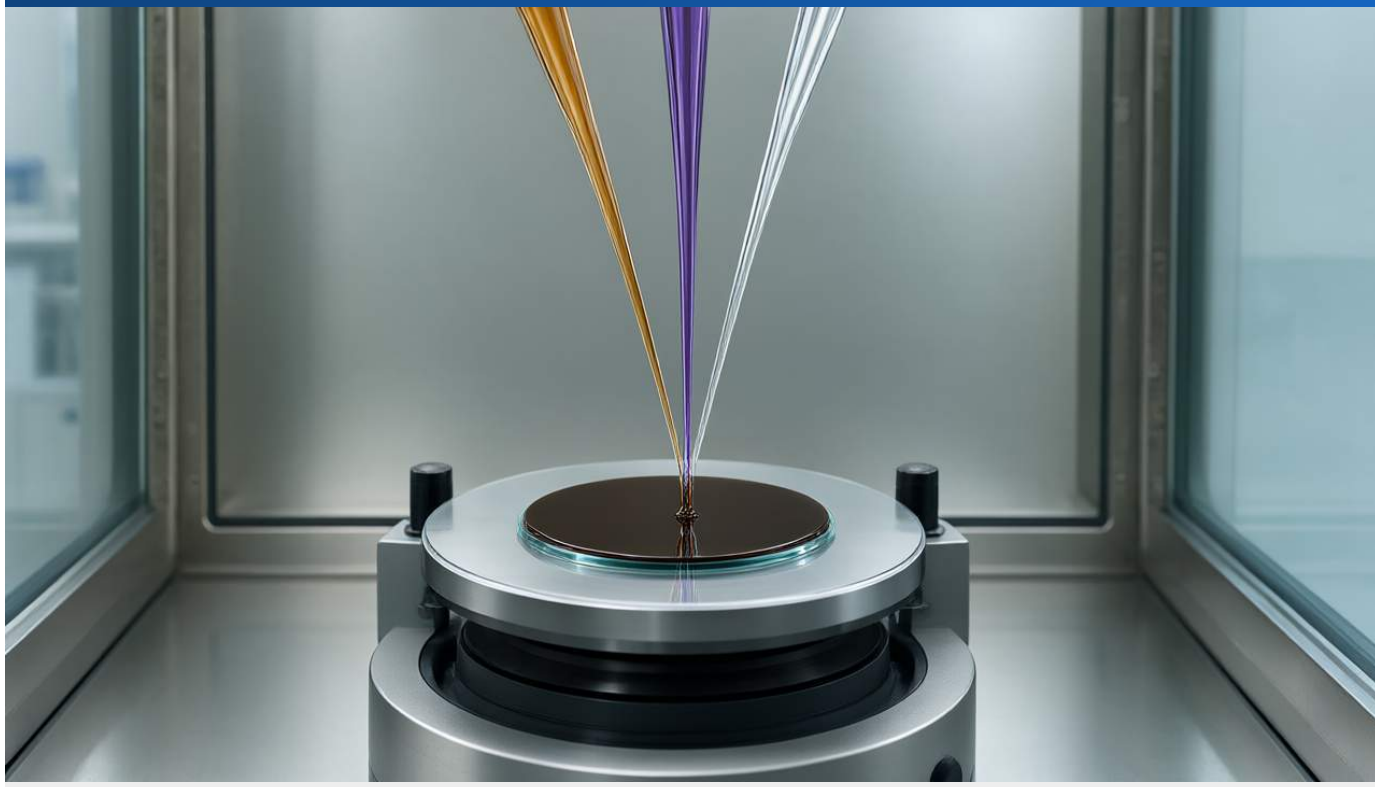
This research, reported in *Joule*, demonstrates that practical changes in chemistry can resolve nanoscale defects that undermine long-term reliability. By simultaneously increasing efficiency and durability, the findings provide a blueprint for high-performance solar technologies and bring perovskite-silicon tandems closer to commercial deployment.

Source: <https://micro.org.au/news/molecular-makeover-boosts-solar-performance/>

Collected: October 17, 2026 | Automated Research System (AI)

#07 Inverted Perovskite Solar Cells: High-Entropy Contacts Reach 27.5% Efficiency

Published October 13, 2026 pv magazine USA



OVERVIEW

Researchers in China have achieved a power conversion efficiency (PCE) of 27.50% in inverted perovskite solar cells by implementing high-entropy molecular contacts (HE-MCs). This three-molecule blend prevents the collapse of molecular packing under thermal stress, significantly enhancing both operational stability and device performance.

Key Findings

The development of high-entropy molecular contacts (HE-MCs) has pushed the power conversion efficiency (PCE) of inverted perovskite solar cells to a champion value of 27.50% under reverse-scan conditions. The Tianjin Institute of Metrological Supervision and Testing independently certified a steady-state efficiency of 27.31% for one of the devices. Compared to devices using a single-component CbzNaph contact, the HE-MC-based cells improved average PCE from 26.37% to 27.29%, driven by enhancements in open-circuit voltage (VOC) and fill factor (FF).

Technical Details

The HE-MCs were created by blending three carbazole-based molecules—CbzNaph, CbzNaphBF, and CbzNaphBT—at a 1:1:1 molar ratio. CbzNaphBF and CbzNaphBT incorporate oxygen- and sulfur-containing units, respectively, to create diverse intermolecular interactions and non-centrosymmetric units that promote complex molecular stacking. The fabrication process involved:

- Spin-coating the molecular blend onto fluorine-doped tin oxide (FTO) glass, followed by annealing at 100 C for 10 minutes.
- Depositing a perovskite absorber (1.55 eV bandgap) via a two-step spin-coating process with chlorobenzene as an antisolvent, annealed at 100 C for 30 minutes.
- Applying a 30 nm fullerene (C60) layer, a 40 nm tin oxide (SnO₂) layer, and a 100 nm copper rear electrode.
- Adding a 120 nm magnesium fluoride coating to the back of the glass to minimize reflection losses.

The champion device recorded a VOC of 1.202 V, a short-circuit current density of 26.40 mA/cm², and a fill factor of 86.67%.

Background & Context

Conventional single-component molecular contacts often suffer from thermal instability, where thermal stress causes the loss of ordered molecular packing, accelerating device degradation. The research team, comprising scientists from City University of Hong Kong, Jilin University, and Sun Yat-sen University, sought to balance ordered self-assembly with high-entropy structural complexity to prevent this collapse. Their findings were published in Nature Photonics.

Significance & Outlook

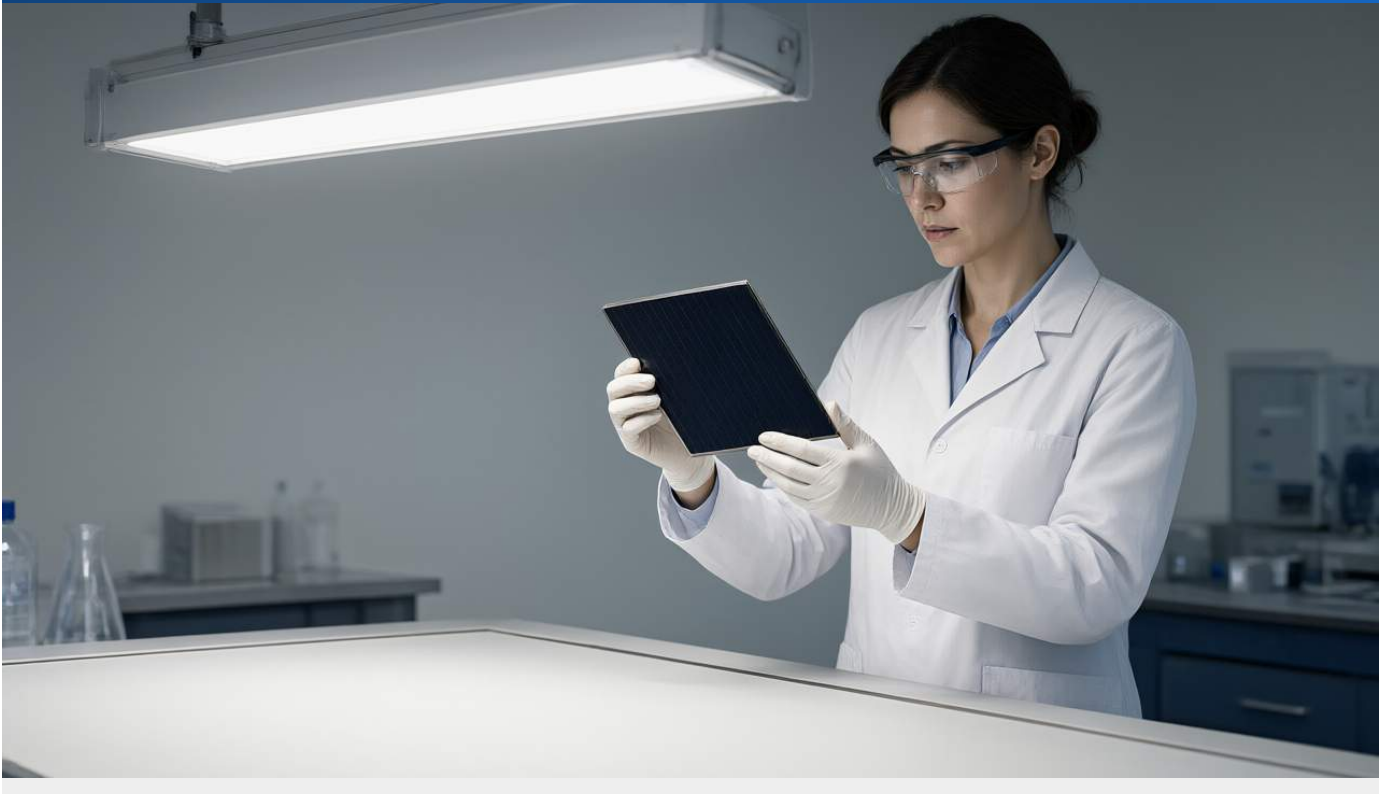
The HE-MC approach addresses the critical trade-off between efficiency and long-term operational stability. The devices were evaluated through prolonged exposure to 85 C, thermal cycling, and maximum power point tracking under continuous one-sun illumination at 85 C. This result is closely competitive with a May 2026 report of 27.41% efficiency for inverted cells achieved by researchers from Shaanxi Normal University and Linköping University.

Source: <https://www.pv-magazine.com/2026/10/13/three-molecule-blend-boosts-inverted-perovskite-solar-cell-efficiency-to-27-5/>

Collected: October 17, 2026 | Automated Research System (AI)

#08 Perovskite Solar Submodules: UNSW and UtmoLight Record 23.5% Efficiency

Published October 13, 2026 Mercom India India



OVERVIEW

Researchers from UNSW Sydney and UtmoLight have achieved a world-record certified stabilized power conversion efficiency of 23.5% for a large-area perovskite solar submodule. This benchmark narrows the gap between large-scale modules and small-area laboratory cells, demonstrating the scalability of high-efficiency perovskite manufacturing.

Key Findings

UNSW Sydney and UtmoLight have established a new world record for a large-area perovskite solar submodule, achieving a certified stabilized power conversion efficiency of 23.5%. The submodule measures 30 × 30 cm with an aperture area of 676 cm², surpassing the previous efficiency benchmark by 0.6 percentage points.

Technical Details

To achieve this result, researchers eliminated the conventional nickel oxide layer typically used in perovskite solar cells, as this material can react adversely with perovskites and cause instability. Instead, they developed an alternative fabrication process that allows a hole-selective contact to form directly during manufacturing, reducing the total number of processing steps.

The collaboration leveraged UtmoLight's expertise in module fabrication and large-area processing to translate laboratory-scale material concepts into a high-performance submodule. This approach allows researchers to assess scalability earlier in the development cycle, avoiding the investment of years into materials that may not be compatible with industrial-scale manufacturing.

Background & Context

Perovskites are valued for their high efficiency and potential for low-cost manufacturing. They are frequently combined with traditional silicon cells to create tandem solar cells, which capture different parts of the solar spectrum to increase total electricity output. However, widespread adoption is currently hindered by degradation when exposed to heat, moisture, and prolonged sunlight, as well as the difficulty of maintaining film uniformity and electrical interconnection in large modules.

Significance & Outlook

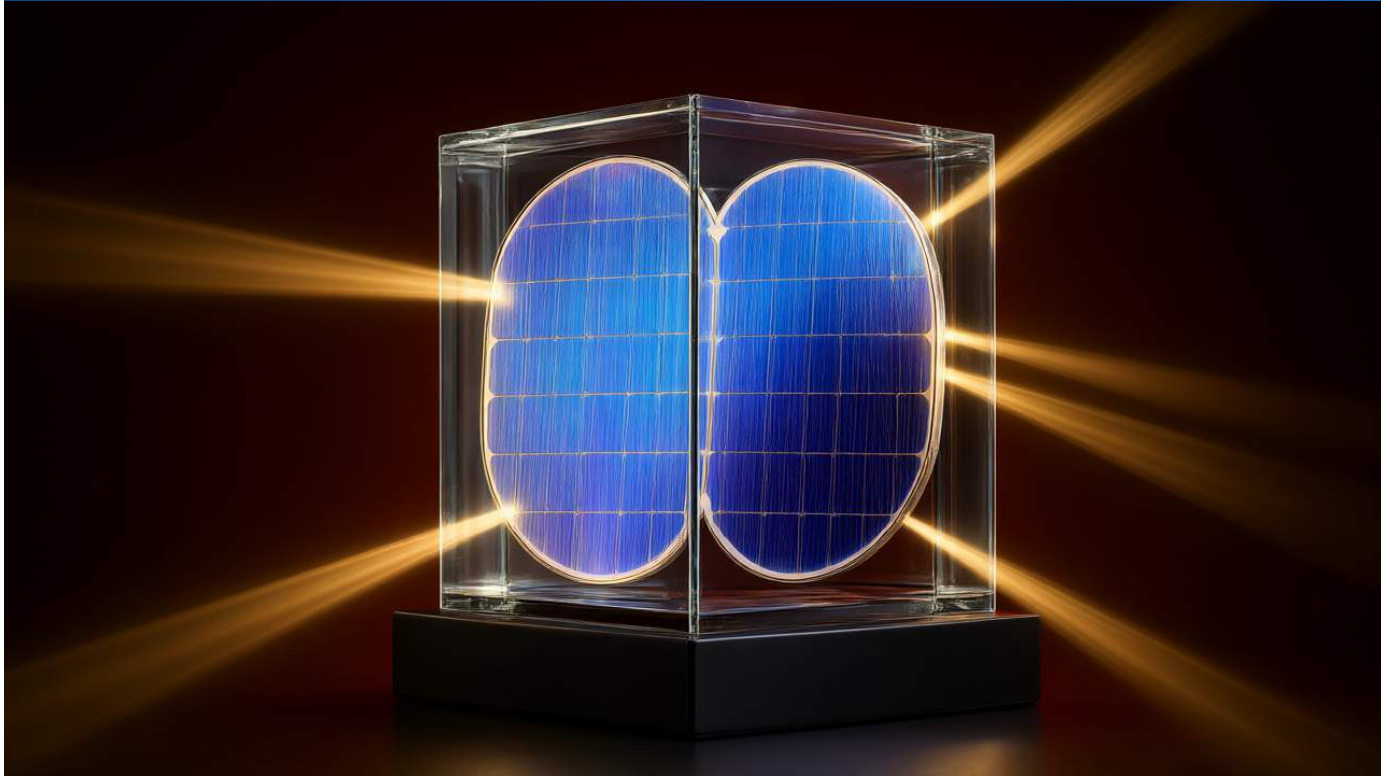
This breakthrough demonstrates that perovskites can maintain the high efficiency required for scalable manufacturing. In the coming months, the researchers plan to develop a full-scale perovskite solar module with an area of 2.8 m², targeting an efficiency of approximately 18%–19%. Despite this progress, the technology requires further improvements in reproducibility, long-term stability, and efficiency before wide deployment is viable.

Source: <https://www.mercomindia.com/australian-researchers-claim-record-perovskite-submodule-efficiency>

Collected: October 17, 2026 | Automated Research System (AI)

#09 China PV Export Controls: Perovskite and Tandem Tech Restrictions 2026

Published October 16, 2026 pv magazine Global / China's Ministry of Commerce (Mofcom) and Ministry of Industry and Information Technology (MIIT) USA



OVERVIEW

China's Ministry of Commerce (Mofcom) and Ministry of Industry and Information Technology (MIIT) have proposed banning the export of high-efficiency perovskite and tandem solar manufacturing technologies. The proposal targets specific production processes and equipment, potentially limiting international access to next-generation PV manufacturing know-how.

Key Findings

China has proposed adding 12 photovoltaic technologies to its Catalogue of Technologies Prohibited or Restricted from Export. Published on Oct. 16 under Joint Announcement No. 48 of 2026, the proposal is part of a broader consultation on 40 technologies across AI, biomedicine, and solar energy, with public comments open until Nov. 15.

Technical Details

The proposed export bans specifically target manufacturing technologies and equipment for:

- Perovskite-silicon tandem solar cells based on wafers of at least 182 mm with conversion efficiencies of 30% or higher.
- Perovskite slot-die coating processes with widths of at least 1.1 meters.
- Single-junction perovskite modules of at least 1 square meter with efficiencies of 18% or higher.
- Perovskite tandem modules of at least 1 square meter with efficiencies of at least 28%.
- Trichlorosilane production via cold-hydrogenation fluidized-bed processes (annual single-line capacity $\geq 250,000$ metric tons) and silane-based fluidized-bed processes (annual capacity $\geq 20,000$ metric tons).
- Silicon wafers no thicker than 70 micrometers and specific edge-passivation technologies for thin crystalline-silicon cells.

Additionally, the "restricted-export" category includes polysilicon plant engineering for lines with annual capacities of at least 30,000 metric tons, advanced crystal-pulling, wafer-cutting, and high-performance processes for TOPCon, BC, and HJT cells. HJT provisions include p-type technologies evaluated under air mass zero (AM0) conditions for space applications.

Background & Context

Mofcom cited national security concerns, noting that PV technologies are increasingly used in defense and aerospace. While finished modules remain exempt, the controls target the "know-how," including licensing, equipment exports, and on-site technical support. An interim registration requirement for these technologies took effect on Oct. 16.

Significance & Outlook

If adopted, these measures could reinforce China's dominance in advanced PV manufacturing by slowing the ability of overseas manufacturers to close the technological gap. However, the restrictions may also complicate the international expansion of Chinese firms and increase trade tensions.

Source: <https://pv-magazine-usa.com/2026/10/16/china-proposes-ban-on-exports-of-perovskite-tandem-solar-manufacturing-technology/>

Collected: October 17, 2026 | Automated Research System (AI)

#10 Perovskite-Silicon Tandem Cells: 32.3% Efficiency via Electrode Redesign

Published October 14, 2026 Perovskite-Info China



OVERVIEW

Researchers have achieved a certified efficiency of 32.28% (champion efficiency of 33.06%) for perovskite-silicon tandem solar cells by optimizing the front electrode. The improvement stems from replacing standard transparent conductive oxides with tungsten-doped indium oxide (IWO) and optimizing metal grid geometry. This approach enhances electron extraction and light transmission without altering the light-absorbing layers.

Key Findings

A collaborative research team from Southwest Petroleum University, the Chinese Academy of Sciences, Shanghai Normal University, Chongqing University, and the University of Chinese Academy of Sciences has pushed the certified efficiency of perovskite-silicon tandem solar cells to 32.28%, with a champion efficiency reaching 33.06%. This performance gain was achieved specifically through the redesign of the front electrode rather than modifications to the light-absorbing layers.

Technical Details

The team replaced the conventional indium zinc oxide in the front electrode with tungsten-doped indium oxide (IWO). IWO provides a lower work function, which improves electron extraction, and increases the transmission of near-infrared light to the bottom silicon cell. With identical metal grids, this change increased champion efficiency from 31.65% to 32.49%, driven primarily by a fill factor increase from 78.74% to 79.51%.

To further optimize performance, the researchers developed a simulation tool to balance the trade-off between grid line shading and resistance losses. Experimental results indicated that the optimal configuration consisted of lines approximately 50 μm wide with a spacing of 2.5 mm. This optimization resulted in a champion cell with the following specifications:

- Open-circuit voltage: 1.973 V
- Short-circuit current density: 20.72 mA/cm^2
- Fill factor: 80.87%

Stability and Manufacturing

Stability tests on unencapsulated cells showed that those using the IWO electrode retained 91.3% of their initial efficiency after 500 hours of maximum power point tracking under one-sun illumination, outperforming the 86.1% retention of standard electrodes.

The researchers noted that the design rules are applicable to industrial manufacturing, as current methods—including electroplating, screen printing, and laser transfer printing—can produce metal lines as narrow as 10 μm .

Significance and Outlook

While these results were achieved on small-area devices, the team identified several remaining challenges for scaling. These include the reduction of indium usage and the achievement of uniform, large-area deposition of the transparent oxide within the temperature constraints of perovskites.

Source: <https://www.perovskite-info.com/electrode-redesign-pushes-perovskite-silicon-tandem-solar-cells-323-certified>

Collected: October 17, 2026 | Automated Research System (AI)

#11 $(\text{NDI-dH})_2\text{AgBiI}_4$: Lead-Free Perovskite Photoanode for Water Use

Published October 11, 2026 EPFL's LIMNO lab (reposted on a blog) Switzerland



OVERVIEW

Researchers at EPFL's LIMNO lab have developed a lead-free layered double perovskite, $(\text{NDI-dH})_2\text{AgBiI}_4$, capable of operating as a photoanode in water. By utilizing a water-repelling naphthalene diimide spacer, the material achieves higher carrier mobility and stability compared to aliphatic or benzene-based alternatives. This development enables the use of this material class in liquid-contact applications such as solar-fuel production and biosensors.

Key Findings

The LIMNO lab at EPFL, led by Kevin Sivula, has created the first lead-free layered double perovskite that can function in water. The material, $(\text{NDI-dH})_2\text{AgBiI}_6$, demonstrated a photocurrent of 0.25 mA/cm^2 at $+1.0 \text{ V}$ against a reversible hydrogen electrode under one-sun illumination when used as a photoanode in a water-based electrolyte containing a sacrificial electron donor.

Technical Details

The stability and performance of the material are attributed to the use of naphthalene diimide, a bulky, water-repelling organic spacer. Technical comparisons against spacers using benzene-based or simple aliphatic chains revealed the following:

- In-plane carrier mobility was threefold higher.
- Trap density was an order of magnitude lower.
- Structural integrity was maintained during accelerated testing (24 hours at 30°C and 80% relative humidity), whereas the other two versions bleached and lost their layered structure.

While the bare film degraded gradually during operation, the addition of a hole-transporting polymer overlayer allowed the device to run for more than an hour, though this resulted in some loss of photocurrent. Notably, the organic spacer does not merely serve as a scaffold; it also absorbs light, contributing to the overall photocurrent.

Background & Context

Layered hybrid double perovskites are considered promising for optoelectronic and solar applications. However, their inherent sensitivity to water has historically prevented their application in environments where semiconductors must touch liquids, such as in biosensors or the production of solar fuels.

Significance & Outlook

The results indicate that spacer engineering is a viable pathway toward creating stable, lead-free perovskite photoelectrodes. By optimizing the organic components to repel water while maintaining electronic properties, researchers can expand the utility of lead-free perovskites into aqueous environments.

Source: <https://www.perovskite-info.com/water-repelling-spacer-lets-lead-free-perovskite-work-photoanode-water>

Collected: October 17, 2026 | Automated Research System (AI)

#12 Solvent-Free Tandem Solar Cells: Industrial Scalability and Specs

Published October 13, 2026 WSSET International



OVERVIEW

A new fully solvent-free production approach for tandem solar cells demonstrates high stability, retaining 97.06% of initial efficiency after 6,800 hours. By utilizing physical vapour deposition, the process eliminates toxic solvents to reduce environmental risks and contamination. This development provides a scalable route for the industrial manufacturing of next-generation photovoltaics.

Key Findings

The study confirms that a fully solvent-free approach to tandem solar cell production can deliver the efficiency and stability required for industrial-scale manufacturing. A primary result of this research is the demonstrated long-term stability of the cells, which retained 97.06% of their initial efficiency after 6,800 hours of testing.

Technical Details

The manufacturing process utilizes physical vapour deposition to construct the solar cells. This specific technical transition removes the need for toxic solvents typically used in production. By eliminating these chemical agents, the process achieves two critical technical improvements: the reduction of contamination within the cell structure and the mitigation of environmental risks associated with solvent handling and disposal.

Background & Context

Traditional tandem solar cell fabrication often relies on solvent-based methods that can introduce impurities or create hazardous waste streams. The shift toward a solvent-free methodology addresses these industrial bottlenecks. The research specifically tests whether removing these solvents compromises the performance or durability of the cell, concluding that the resulting cells maintain high efficiency over extended periods.

Significance & Outlook

The transition to physical vapour deposition offers a scalable route toward the industrial manufacturing of next-generation tandem solar cells. By removing toxic components and ensuring stability over thousands of hours, this approach aligns the technology with the rigorous requirements of commercial solar production. This methodology enhances the scalability of clean energy by providing a cleaner, more stable path from laboratory research to large-scale industrial application.

Source: <https://wsset.org/news/how-do-solvent-free-tandem-solar-cells-boost-clean-energy-scalability/>

#13 Perovskite Solar Cells: UV Stability and Outdoor Degradation 2024

Published October 16, 2026 Optics.org / Science USA



OVERVIEW

Researchers have developed a hybrid polymer hole-transport layer that reduces ultraviolet degradation in perovskite solar cells (PSCs). A champion module maintained over 16% operational efficiency after 29 weeks of outdoor testing, bridging the gap between laboratory and real-world durability.

Key Findings

A study funded by the U.S. Department of Energy (DOE) has demonstrated that a novel hybrid polymer material significantly improves the ultraviolet (UV) stability and efficiency of perovskite solar cells (PSCs) in outdoor environments. The research, published in *Science*, highlights a champion module that achieved an initial efficiency increase to approximately 16% and maintained operational efficiency above 16% after 29 weeks of outdoor exposure.

Technical Details

The research team focused on p-i-n structured PSCs utilizing organic hybrid hole transport materials (HTMs). The investigation identified that degradation under sunlight with strong UV components is primarily driven by weak chemical bonding between three specific layers: the perovskite layer, the polymer HTM layer, and the transparent conducting oxide (TCO) layer.

To mitigate this, the researchers synthesized a hybrid polymer designed to strengthen the chemical bonding at the perovskite/HTM/TCO region. This approach addresses the instability caused by the interaction of perovskite thin-films with moisture, oxygen, heat, and applied voltage under fluctuating outdoor conditions of irradiance and temperature.

Background & Context

The study was led by the University of North Carolina at Chapel Hill, with contributions from the Colorado School of Mines, National Renewable Energy Laboratory (NREL), University of California, San Diego, and University of Toledo. Results were independently verified by the DOE's Perovskite PV Accelerator for Commercializing Technologies (PACT) center.

The PACT center was established in 2021 by the DOE Solar Energy Technologies Office (SETO) to create testing and evaluation standards for the rapidly evolving perovskite PV technology, moving beyond controlled lab environments and LED light sources.

Significance & Outlook

This research represents the first published demonstration of outdoor performance for perovskite mini modules with an area greater than 15 cm² maintaining an aperture efficiency above 16% after 29 weeks. By identifying the specific chemical bonding mechanisms that lead to UV degradation, the study provides a critical step toward the commercialization of reliable, high-efficiency perovskite photovoltaics.

Source: <https://optics.org/news/nrel-examines-degradation-mechanisms-of-perovskite-solar-cells>

Collected: October 17, 2026 | Automated Research System (AI)

#14 Perovskite Solar Cells: Defect Reduction via Chemical Mixtures

Published October 13, 2026 Princeton Engineering USA



OVERVIEW

Researchers at Princeton Engineering and partner institutions have reduced atomic-level defects in perovskite crystals by adding a combination of zinc bromide and methyl ammonium chloride. This technique allows electrons to retain energy 10 times longer than untreated perovskites, potentially increasing power generation by 1% in cutting-edge cells.

Key Findings

A research team led by faculty at Princeton, the University of California-San Diego, and Sungkyunkwan University has developed a method to mitigate microscopic defects in perovskite crystals. By introducing a specific chemical mixture during fabrication, the team produced perovskites that allow electrons to retain excess energy for up to 300 microseconds—approximately 100,000 times longer than many other semiconductors. This improvement could translate to a 1% increase in power generation for the most advanced perovskite solar cells.

Technical Details

The fabrication process involves adding a mixture of zinc bromide and methyl ammonium chloride early in the production stage. The effectiveness of this approach relies on the two chemicals having a lower melting point when combined. This chemical intervention reduces atomic-level defects in the crystalline structure that typically dampen the ability of electrons to retain energy after absorbing sunlight. Because perovskite ingredients can be prepared in liquid form, these materials can be fabricated by printing them in sheets.

Background and Context

Perovskites are semiconductors with complex crystalline structures suited for converting solar energy into electricity. While silicon remains the industry standard due to its durability, perovskites offer a cheaper and more sustainable production alternative. Current trends involve "tandem solar cells," where a thin layer of perovskite is placed over a silicon cell; these configurations generate about 40% more power than single-material cells. However, the printing and layering process often introduces the defects that this new research addresses.

Significance and Outlook

The ability to create low-defect perovskite layers provides a scalable way to augment standard silicon cells, addressing rising energy demands for AI and datacenter infrastructure. Beyond photovoltaics, the extended energy retention of electrons in these crystals broadens the potential applications of perovskites as semiconductors. The findings were published on October 8 in the journal Science under the title "Volatile eutectics to tailor crystallization for perovskite optoelectronics."

Source: <https://engineering.princeton.edu/news/2026/10/13/building-better-solar-tech-crystal-time>

Collected: October 17, 2026 | Automated Research System (AI)