Perovskite solar

Weekly Intelligence Report

2026-05-31 | 21 articles | 6 countries

troy-technical.jp

This Week's Keyword

Perovskite Scale-Up

Efficiency, Stability, & Commercialization Drive

21 articles	6 countries	33.0 %	>9700 hours
Total Articles Analyzed	Source Countries/Regions	Highest PCE (Tandem)	Extrapolated T90 Lifetime

All 21 Articles This Week — 5-Axis Evaluation Matrix

How to read columns — Tech Novelty: degree of breakthrough Market Proximity: closeness to commercialization Market Impact: industry-wide effect Data Reliability: quantitative data & peer review US/EU Relevance: direct impact on US/European companies & supply chains

#	Article Title	Type	Tech Novelty	Market Proximity	Market Impact	Data Reliability	US/EU Relevance	Summary
#01	Novel Passivation Strategy	Research	●●●●○	●●○○○	●●●●○	●●●●○	●●●●○	Chinese team achieves 33% efficiency and 1000h stability in perovskite/silicon tandem cells via novel Al2O3 passivation.
#02	Perovskite Cells in 2026	Market Overview	●○○○○	●●●●●	●●●●○	●●○○○	●●●●●	2026 overview highlights perovskite transition to commercialization, focusing on stability, scalable manufacturing, and lead management.
#03	Organic Optoelectronic Device	Research	●●●●○	●○○○○	●●●○○	●●●●●	●●●○○	Japanese scientists create organic device for simultaneous light harvesting and emission, achieving >1% PCE/EQE, offering flexibility.
#04	Additive-Assisted Annealing	Research	●●●●○	●●○○○	●●●●○	●●●●●	●●●●○	Additive-assisted annealing with 1,4-butanesultam boosts perovskite PCE to 26.79% and 1000h stability (95% retention).
#05	Testing Equipment Guide	Industry Guide	●○○○○	●●●●●	●●●○○	●●●○○	●●●●○	Guide details critical testing equipment selection for perovskite pilot lines, covering efficiency, stability, and data management.
#06	Laser Scribing Buyer's Guide	Industry Guide	●○○○○	●●●●●	●●●○○	●●●○○	●●●●○	Buyer's guide for perovskite laser scribing equipment stresses aligning selection with R&D;/production needs for efficiency.
#07	Mfg Line Guide	Industry Guide	●○○○○	●●●●●	●●●●○	●●●○○	●●●●○	Comprehensive guide outlines building a perovskite module manufacturing line, from substrate prep to testing, stressing integration.
#08	Laser Proc. Pitfalls	Industry Guide	●○○○○	●●●●●	●●●○○	●●●○○	●●●●○	Article warns against common pitfalls in purchasing perovskite laser processing equipment, urging clear requirements and supplier expertise.
#09	Thermodynamic Inhibition	Research	●●●●●	●○○○○	●●●●●	●●●●●	●●●●●	UK research achieves 32.52% certified PCE and >9700h extrapolated T90 stability in perovskite-silicon tandem cells via thermodynamic inhibition.
#10	World Record All-Perov	Research	●●●●●	●●○○○	●●●●●	●●●●●	●●●●○	Chinese researchers set world record 30.3% efficiency for rigid all-perovskite tandem solar cells, 28.0% for flexible.
#11	Renshine/Jingling Alliance	Corporate Strategy	●●○○○	●●●○○	●●●○○	●●○○○	●●●●○	Renshine Solar and Jingling Technology form alliance for advanced perovskite materials, targeting utility-scale and space PV.

#	Article Title	Type	Tech Novelty	Market Proximity	Market Impact	Data Reliability	US/EU Relevance	Summary
#12	Enecoat Space PV	Corporate Strategy	●●●○○	●●●○○	●●●●○	●●○○○	●●●○○	Japan's Enecoat targets 2035 commercialization for space-grade flexible perovskite solar cells, with terrestrial pilot in 2027.
#13	Transparent Perovskite	Research	●●●●○	●●○○○	●●●●○	●●●●○	●●●○○	NTU Singapore develops ultra-thin, transparent, color-neutral perovskite solar cells for BIPV and vehicles, efficient under diffuse light.
#14	Sekisui ¥100B Investment	Corporate Strategy	●●○○○	●●●●○	●●●●○	●●●●○	●●●●○	Sekisui Chemical invests ¥100B in flexible perovskite solar cells, aiming for ¥25B sales and profitability by FY2028.
#15	China Space Testing	Research	●●●○○	●●○○○	●●●●○	●●○○○	●●●●○	China launches perovskite solar cells into space on Shenzhou-23 for 6-month in-orbit testing of stability and radiation resistance.
#16	Nano/Micro-Textures	Research	●●●○○	●○○○○	●●●○○	●●●●●	●●●○○	Review highlights nano/micro-textures in perovskite cells improve wettability, crystallinity, carrier extraction, and mechanical stability.
#17	PID Mitigation	Research	●●●●○	●●○○○	●●●●○	●●●●●	●●●●●	US research shows positive-voltage systems mitigate potential-induced degradation (PID) in perovskite solar cells, maintaining >95% efficiency for 168h.
#18	Lab to Product Reality	Market Overview	●○○○○	●●●●●	●●●●○	●●●○○	●●●●●	Review details perovskite PV commercialization challenges like uniform films, stability, and encapsulation, stressing industry-academia collaboration.
#19	Photodetector Arch.	Research	●●●●○	●○○○○	●●○○○	●●●●●	●●●○○	Chinese research develops self-powered perovskite photodetector with 'chocolate-chip-cookie' architecture for enhanced spectral sensing.
#20	Sn-Pb Tandem Cells	Research	●●●●○	●●○○○	●●●●○	●●●●●	●●●●○	Viscoelastic grain-boundary regulation enables 21.02% Sn-Pb single and 26.94% all-perovskite tandem cells via scalable blade-coating.
#21	Additive Engineering	Research	●●●●○	●●○○○	●●●●○	●●●●●	●●●●○	Additive engineering with ANdPy mitigates residual stress, boosts stability, and achieves 18.52% PCE in wide-bandgap perovskite solar cells.

●●●●○ High ●●●○○ Med-High ●●○○○ Med ●○○○○ Low | Yellow highlight = featured article

Three Questions That Demand Your Decision This Week

❶ Is your PV R&D; roadmap competitive with 33% efficiency and >9700h stability?

Recent breakthroughs from China and the UK demonstrate perovskite/silicon tandem cells reaching 33% PCE and extrapolated T90 lifetimes exceeding 9700 hours. This sets a new benchmark for both efficiency and long-term stability. Does your current R&D; strategy account for these aggressive performance targets, or risk falling behind global leaders?

❷ How will China's rapid commercialization and space ambitions impact your supply chain?

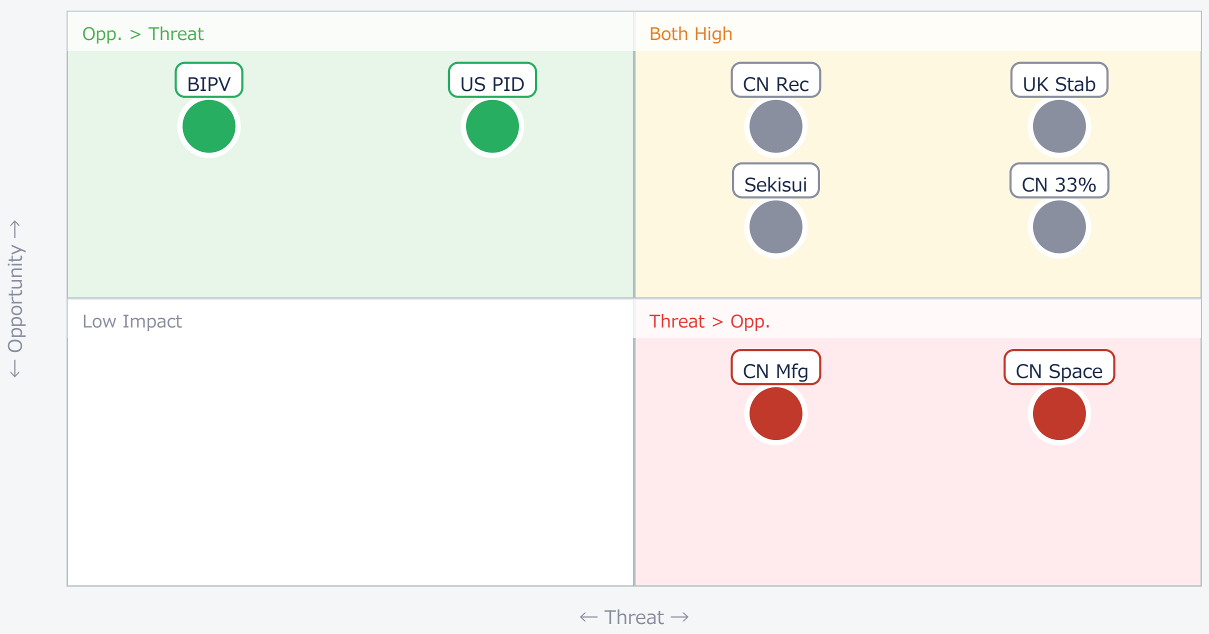
Chinese entities are not only achieving world-record efficiencies (30.3% all-perovskite) but also actively launching perovskite cells into space for testing and providing comprehensive manufacturing line guides. This signals a concerted effort to dominate the entire value chain, from materials to end-applications. Is your supply chain exposed to potential disruptions or competitive pressures from this rapid advancement?

❸ Are you prepared for the market entry of flexible and transparent perovskite solutions?

Japanese firms like Sekisui Chemical are making ¥100 billion investments targeting FY2028 profitability in flexible perovskite cells for BIPV, vehicles, and IoT. Singaporean researchers are developing ultra-thin transparent cells for windows. These applications represent significant new market segments. Does your product portfolio and business development strategy address these emerging form factors and their unique installation requirements?

Opportunities vs. Threats for US/European Companies

Opportunity vs. Threat Matrix for US/European Companies



Item	Quadrant	↑ Opportunity	↓ Threat
● UK Stab	Critical	License tech	Lag in stability
● CN Rec	Critical	New form factors	China leads efficiency
● CN 33%	Critical	Next-gen tandem	China leads tandem
● Sekisui	Critical	Flexible PV mkt	New competitor

● CN Space	Threat	Space PV mkt	China space lead
● CN Mfg	Threat	Mfg insights	China mfg scale
● US PID	Opp.	Enhance reliability	Integration cost
● BIPV	Opp.	New BIPV prod	Niche market

Deep Dive ① — Record Stability for Tandem Perovskites

#09 | 2026/05/30 | Energy & Environmental Science (RSC Publishing) | Tech Novelty●●●●● Proximity●○○○○ Market Impact●●●●● Data Reliability●●●●● US/EU Relevance●●●●●

UK researchers achieved a certified 32.52% PCE for perovskite-silicon tandem cells with an extrapolated T90 lifetime exceeding 9700 hours. This breakthrough stems from a novel 'thermodynamic inhibition' strategy that suppresses the nucleation of bromine-rich phases, a key cause of instability in wide-bandgap perovskites.

This method precisely controls crystal growth during film formation, leading to single-junction devices (1.68 eV) maintaining 98% efficiency over 2240 hours. This addresses a critical barrier to commercialization by demonstrating exceptional long-term operational stability alongside high efficiency.

> ▶ Strategic Analyst's Perspective
>
> Strategic Analyst's Perspective: The published numbers for efficiency and extrapolated lifetime are highly significant and appear realistic given the peer-reviewed source. The technical barrier remaining is scaling this precise thermodynamic control to large-area manufacturing without compromising uniformity or cost-effectiveness. [Opportunity] for US/EU materials suppliers to develop compatible precursor materials or for OEMs to license this foundational IP to integrate into next-gen tandem platforms. [Threat] is falling behind in fundamental stability science, making US/EU products less competitive on lifetime guarantees. Next Action: [R&D;] Evaluate this thermodynamic inhibition mechanism for integration into existing perovskite formulations by end of Q3 2026. [Strategy] Assess potential IP licensing opportunities from UK institutions.

Deep Dive ② — World Record All-Perovskite Tandem Cells

#10 | 2026/05/24 | Knowridge | Tech Novelty●●●●● Proximity●●○○○ Market Impact●●●●● Data Reliability●●●●● US/EU Relevance●●●●○

Chinese researchers at NIMTE achieved a certified world-record efficiency of 30.3% for rigid all-perovskite tandem solar cells, with flexible counterparts reaching 28.0% PCE. This breakthrough utilizes the Hard-Soft Acid-Base (HSAB) theory to homogenize crystal formation, addressing manufacturing challenges.

This achievement pushes all-perovskite technology into direct competition with silicon-based tandems and opens significant possibilities for lightweight, bendable solar cells in BIPV, wearables, and mobile power. The HSAB theory provides a new framework for material selection and process optimization for large-scale manufacturing.

▶ Strategic Analyst's Perspective

Strategic Analyst's Perspective: A 30.3% certified efficiency for all-perovskite tandems is a game-changer, and the 28.0% for flexible cells is equally impressive. These numbers are credible given the source (Nature Nanotechnology). The primary technical barrier is translating this lab-scale precision to industrial-scale, high-throughput manufacturing while maintaining cost-effectiveness and long-term stability. [Opportunity] for US/EU OEMs to explore flexible perovskite applications for niche markets (e.g., IoT, specialized BIPV) where weight and form factor are critical. [Threat] is China establishing a dominant lead in all-perovskite and flexible PV, potentially controlling future supply chains and IP. Next Action: [R&D;] Benchmark current flexible PV capabilities against 28% PCE and investigate HSAB theory applications by Q4 2026. [Business Dev] Identify emerging flexible PV market segments for early entry.

Deep Dive ③ — 33% Perovskite/Silicon Tandem Efficiency

#01 | 2026/05/28 | Chinese Academy of Sciences | Tech Novelty●●●●○ Proximity●●○○○ Market Impact●●●●○ Data Reliability●●●●○ US/EU Relevance●●●●○

Chinese researchers developed a novel passivation strategy using polystyrene nanospheres to template an ultrathin aluminum oxide layer on pyramid-textured silicon substrates. This effectively blocks electrical leakage, boosting perovskite/silicon tandem cell efficiency to a certified 32.89% (approx. 33%) for 1 cm^2 cells.

The innovation also significantly improved operational stability, retaining about 90% of initial efficiency after 1,000 hours of continuous operation. This addresses a critical challenge for scaling tandem cells, as conventional passivation struggles with textured surfaces, paving the way for larger module manufacturing.

▶ Strategic Analyst's Perspective

Strategic Analyst's Perspective: The 33% efficiency is a new benchmark, and 1000 hours at 90% retention is a strong indicator of progress. These figures are realistic for lab-scale devices. The main technical barrier is the scalability of the polystyrene nanosphere templating and ALD process for large-area, high-throughput manufacturing. [Opportunity] for US/EU equipment manufacturers to develop ALD tools optimized for textured surfaces and for materials companies to provide high-purity ALD precursors. [Threat] is China's rapid advancement in high-efficiency tandem cell architectures, potentially outcompeting US/EU firms on performance metrics. Next Action: [R&D;] Initiate a competitive analysis of passivation techniques for textured silicon in tandem cells by Q3 2026. [Procurement] Identify potential Chinese suppliers of advanced passivation materials or equipment for evaluation.

Other Notable Articles

Additive-Assisted Annealing Process Significantly Boosts Perovskite Solar Cell Stability and Efficiency (Bioengineer.org)
Tech Novelty●●●●○ Proximity●●○○○ Market Impact●●●●○

Novel additive (1,4-butanesultam) boosts single-junction PCE to 26.79% and achieves 95% efficiency retention after 1000h, critical for stability.

NTU Singapore Develops Ultra-Thin Transparent Perovskite Solar Cells for Seamless Integration into Windows and Facades (New Atlas)
Tech Novelty●●●●○ Proximity●●○○○ Market Impact●●●●○

Ultra-thin, color-neutral transparent perovskite cells (50x thinner) for BIPV and vehicles, offering new aesthetic and functional applications.

Mitigating Potential-Induced Degradation in Perovskite Photovoltaics Through Positive-Voltage System Architectures (ACS Energy Letters (ACS Publications))
Tech Novelty●●●●○ Proximity●●○○○ Market Impact●●●●○

US research shows PID in perovskite cells can be mitigated by positive-voltage systems, maintaining >95% power for 168h, easing module design.

Viscoelastic Grain-Boundary Regulation in Blade-Coated Tin–Lead Perovskites Enables High-Efficiency Tandem Solar Cells (ACS Publications)
Tech Novelty●●●●○ Proximity●●○○○ Market Impact●●●●○

Scalable blade-coating method for Sn-Pb perovskites achieves 21.02% single-junction and 26.94% all-perovskite tandem efficiency, addressing stability.

Recommended Actions This Week

Action recommendations based on article evaluation matrix and opportunity/threat analysis.

Immediate (this week)

- [Executive] Review competitive landscape for perovskite efficiency and stability, especially from China and UK, to assess strategic gaps.
- [R&D;] Initiate rapid assessment of novel passivation strategies (e.g., Al_2O_3 templating) and additive engineering for stability in tandem cells.
- [Procurement] Begin scouting for advanced testing and laser scribing equipment suppliers, particularly those with perovskite-specific expertise.

Short-term (1 month)

- [Strategy] Conduct a detailed analysis of China's aggressive perovskite commercialization and space PV initiatives to identify potential supply chain risks and market entry strategies.
- [R&D;] Evaluate the feasibility of integrating positive-voltage system architectures for PID mitigation into current perovskite module designs.
- [Business Dev] Explore partnership opportunities with Japanese firms like Sekisui Chemical or Singaporean institutions for flexible/transparent perovskite applications.

Medium-long term (quarter+)

- [R&D;] Establish internal benchmarks for perovskite tandem cell efficiency (33%) and stability (>9700h T90) and allocate resources to meet or exceed them.
- [Legal/IP] Monitor global perovskite IP developments, particularly in high-efficiency and stability domains, to identify licensing opportunities or infringement risks.
- [Strategy] Develop a long-term roadmap for flexible and transparent perovskite PV, including market entry points for BIPV, automotive, and IoT applications.

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PerovskiteSolarCells — Selected Articles

Date: 2026-05-31

Articles: 21

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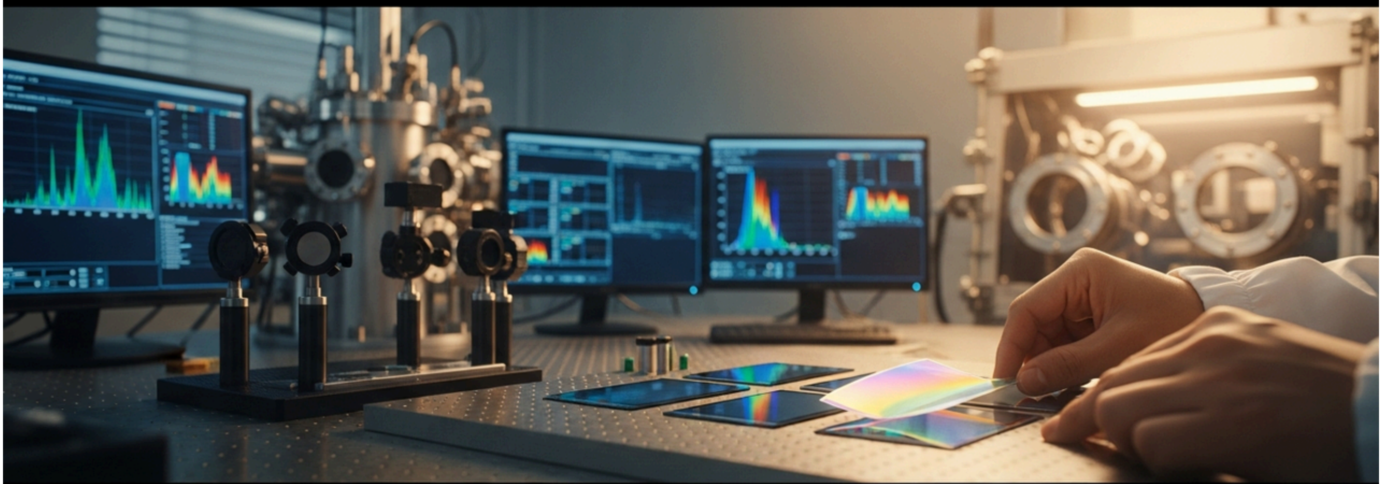
#21 Additive Engineering Mitigates Residual Stress and Boosts Stability in Wide-Bandgap Perovskite Solar Cells

Chinese Researchers Engineer Novel Passivation Strategy for High-Efficiency Perovskite/Silicon Tandem Solar Cells

Published May 28, 2026 Chinese Academy of Sciences China



OVERVIEW

A Chinese research team has developed a novel passivation strategy that significantly boosts the efficiency and operational stability of perovskite/silicon tandem solar cells. By employing polystyrene nanospheres as a template, they precisely deposited a thin aluminum oxide insulating layer on pyramid-textured silicon substrates, effectively blocking electrical leakage pathways. This innovation achieved a certified power conversion efficiency of approximately 33% in 1 cm^2 cells, maintaining about 90% of their initial efficiency after 1,000 hours of continuous operation.

IN DEPTH

Background and Challenges

Perovskite/silicon tandem solar cells hold immense promise for next-generation photovoltaics due to their potential for high power conversion efficiencies (PCEs). However, realizing their full commercial potential has been hindered by two critical challenges: achieving consistently high efficiencies and ensuring long-term operational stability. A major contributor to instability, particularly in devices utilizing pyramid-textured silicon substrates, is electrical leakage pathways created by the uneven surface topography. These shunting paths exacerbate degradation under environmental stresses such as humidity and elevated temperatures, significantly compromising the device's lifespan.

Key Findings and Technical Advancements

Researchers at the Ningbo Institute of Materials Technology and Engineering (NIMTE), Chinese Academy of Sciences, in collaboration with Suzhou University and Taizhou University, have introduced a groundbreaking passivation strategy to address this issue. Their approach involves using polystyrene nanospheres as a precise template to deposit an ultrathin aluminum oxide (Al_2O_3) insulating layer via atomic layer deposition (ALD) selectively on the peaks of the textured silicon surface. This 'peak-selective passivation' method is highly effective in:

- Blocking parasitic electrical shunts localized at the silicon surface asperities.
- Optimizing contact resistance and enhancing carrier transport kinetics across the interface.
- Achieving a certified PCE of 32.89% (reported at approximately 33%) for a 1 cm^2 active area device, representing a new benchmark in tandem cell performance.
- Demonstrating exceptional operational stability, retaining approximately 90% of initial efficiency after 1,000 hours of continuous operation, a significant improvement over previous technologies.

Impact and Outlook

This technical breakthrough is pivotal for accelerating the commercialization of perovskite/silicon tandem solar cells. The ability to effectively mitigate electrical leakage on complex textured surfaces, a challenge that conventional passivation methods struggled with, paves the way for scalable manufacturing of large-area modules. The research team suggests that this strategy is broadly applicable to other types of tandem solar cells and optoelectronic devices, potentially catalyzing innovation across the broader photovoltaic sector. Future efforts will likely focus on further upscaling the technology and optimizing cost-efficiency for industrial deployment, reinforcing China's leadership in advanced solar research.

Source: https://english.cas.cn/newsroom/cas-in-media/202605/t20260528_1160007.shtml

Collected: May 30, 2026 | Automated Research System (Gemini API)

Perovskite Solar Cells in 2026: Navigating the Path to Stability, Scalable Manufacturing, and Commercialization

Published May 23, 2026 YouTube Global/USA

OVERVIEW

As of 2026, perovskite solar cell development is transitioning from lab-scale research to commercialization, focusing on enhancing stability, scaling manufacturing, and ensuring environmental viability. Advances in encapsulation, material composition, and rigorous testing are crucial for long-term device performance. Simultaneously, breakthroughs in scalable deposition methods and high-efficiency perovskite-silicon tandem architectures are driving down costs and boosting energy output, while addressing lead management and recycling plans remains vital for market acceptance.

IN DEPTH

Transitioning from Lab to Market: Critical Hurdles

Perovskite solar cell technology, lauded for its exceptional efficiency potential and material versatility, has witnessed rapid advancements over the past decade. In 2026, the industry's focus is decisively shifting from achieving record efficiencies in academic laboratories to the formidable task of commercializing practical, durable products. This transition phase is underscored by three primary challenges: achieving long-term device stability, establishing cost-effective and scalable manufacturing techniques, and addressing environmental concerns associated with lead-containing materials.

Multifaceted Approaches to Enhance Stability

Device stability remains the paramount factor for the successful outdoor deployment of perovskite solar cells. Researchers and industry players are tackling this through a multi-pronged strategy:

- **Advanced Encapsulation:** Novel encapsulation techniques are being developed using multi-layer barrier films and advanced polymeric materials to provide robust protection against moisture, oxygen, and UV degradation. Hybrid encapsulation combining glass with high-performance resins is showing particular promise.
- **Compositional Engineering and Additives:** To mitigate issues like halide segregation in mixed-halide perovskites, sophisticated compositional tuning involving organic cations and inorganic ions, along with specific additives (e.g., organic amine salts, sulfonate derivatives), is employed to stabilize the perovskite crystal structure. This enhances intrinsic resistance to heat, light, and humidity.
- **Rigorous Stress Testing:** Devices undergo accelerated aging tests adhering to international standards (e.g., ISOS protocols) and extensive outdoor field trials to evaluate durability and ensure reliability under real-world operating conditions, confirming performance longevity over thousands of hours.

Innovations in Manufacturing and Tandem Architectures

For perovskites to compete with conventional silicon photovoltaics, cost-effective and efficient large-scale manufacturing processes are indispensable. Key developments include:

- **Scalable Deposition Methods:** Moving beyond lab-scale spin coating, techniques such as blade coating, slot-die coating, vacuum deposition, and various printing methods are being adapted for large-area module fabrication. These methods offer superior material utilization and higher throughput.
- **Perovskite-Silicon Tandem Cells:** Integrating a perovskite top cell with a silicon bottom cell allows for efficient harvesting of the broader solar spectrum, pushing PCEs into the high 30% range. This tandem architecture is widely considered the leading pathway for next-generation, ultra-high-efficiency solar cells.
- **Module Design Optimization:** Challenges related to resistance losses in large-area modules, achieving uniform film deposition, and defect control are being addressed through optimized module designs, including laser patterning for interconnections and micro-grid architectures.

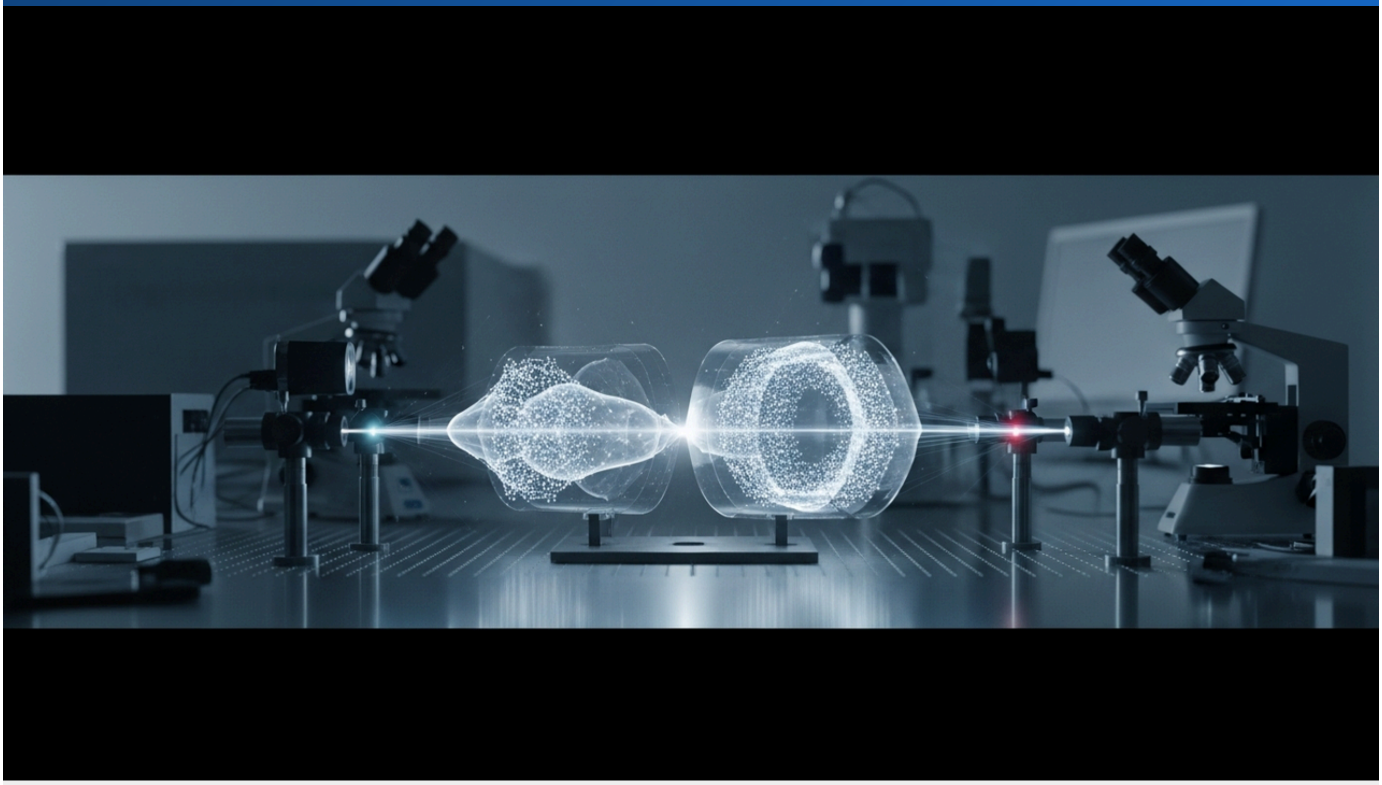
Environmental Considerations and Future Outlook

The presence of lead in most high-performance perovskite formulations poses an environmental concern for widespread commercial adoption. Consequently, significant efforts are focused on developing effective lead sequestration strategies, establishing robust recycling programs, and pioneering lead-free perovskite materials. The commercial success of perovskite solar cells hinges on the industry's ability to overcome these technical and environmental hurdles, thereby building trust in the market. 2026 marks a pivotal juncture where these concerted efforts are expected to materialize into tangible products and commercial deployments.

Source: https://www.youtube.com/watch?v=8a02U4tRqk8

Japanese Scientists Develop Organic Optoelectronic Device Capable of Simultaneous Light Harvesting and Emission

Published May 29, 2026 Photonics Spectra USA



OVERVIEW

Researchers from Tokyo University of Science, Hokkaido University, and Osaka University have developed an organic semiconductor device that simultaneously collects and emits light within a single junction. By effectively suppressing non-radiative recombination, the device achieved both a power conversion efficiency and an electroluminescence external quantum efficiency exceeding 1%. This innovation overcomes previous trade-offs in optoelectronic functionality, paving the way for advanced displays, sensors, and optical communication systems, offering advantages in flexibility and processability over inorganic counterparts like perovskites.

IN DEPTH

New Horizons for Organic Optoelectronics

The ability to integrate photovoltaic functionality (converting light to electricity) with electroluminescence (converting electricity to light) within a single device has been a long-standing goal in optoelectronics. However, these two functions typically impose conflicting material and device architecture requirements, making high-efficiency dual operation a significant challenge. Particularly in organic semiconductor materials, non-radiative losses during carrier recombination have been a major impediment to achieving such bifunctionality.

Development of Hybrid Functional Devices

A collaborative research team from Tokyo University of Science, Hokkaido University, and Osaka University has addressed this challenge by developing a novel organic semiconductor device with a unique material and structural design. Their innovative device exhibits the following key characteristics:

- **Suppression of Non-Radiative Recombination:** Through optimized device architecture and material engineering, the team successfully suppressed non-radiative recombination—a process where electron-hole pairs recombine without emitting light, releasing energy as heat instead. This suppression is critical for enhancing both photovoltaic and electroluminescent efficiencies.
- **Simultaneous High-Efficiency Performance:** The device demonstrated a power conversion efficiency (PCE) exceeding 1% as a solar cell and an external quantum efficiency (EQE) exceeding 1% for electroluminescence. Achieving both functionalities with such efficiencies simultaneously represents a significant breakthrough for hybrid light-harvesting and light-emitting devices.
- **Flexibility and Diverse Applications:** Leveraging the inherent flexibility of organic materials and their relatively low-temperature processing requirements, this device holds potential for a wide range of applications. These include wearable sensors, flexible displays, smart windows, and even advancements in optical communication technologies, offering significant design freedom.

Comparison with Perovskite Solar Cells and Future Outlook

While this research primarily focuses on organic semiconductors, the article contextualizes its advantages relative to inorganic alternatives like perovskites. Perovskite solar cells are known for their high efficiencies but are often rigid and can face stability issues under certain environmental conditions. In contrast, this new organic device offers superior flexibility and the potential for manufacturing through wet processes at near-room temperatures, leading to reduced production costs and greater design versatility. Future research will likely concentrate on further increasing efficiencies and validating long-term durability. This class of hybrid devices lays the groundwork for future integrated electronics that combine energy harvesting with information display and transmission, potentially revolutionizing how we interact with ambient energy.

Source: https://www.photonics.com/Articles/Organic-Device-for-Optoelectronics-Collects-and/p5/a72284

Collected: May 30, 2026 | Automated Research System (Gemini API)

Additive-Assisted Annealing Process Significantly Boosts Perovskite Solar Cell Stability and Efficiency

Published May 22, 2026 Bioengineer.org USA

OVERVIEW

Researchers have developed a novel annealing process that incorporates 1,4-butanesultam as an additive into perovskite precursor solutions, significantly enhancing device performance. This additive effectively alleviates residual strain within the perovskite film, improving crystal quality and boosting power conversion efficiency to 26.79%. Devices demonstrated exceptional stability, retaining 95% of their initial efficiency after 1,000 hours of continuous ISOS-V-2 testing and showing negligible degradation after 1,500 hours of diurnal cycling, marking a major advance for long-term perovskite solar cell viability.

IN DEPTH

Addressing Perovskite Solar Cell Stability Challenges

Perovskite solar cells have achieved power conversion efficiencies (PCEs) comparable to, and in some cases surpassing, those of conventional silicon-based devices. However, their widespread practical application has been largely hampered by insufficient long-term stability, particularly under environmental stresses such as heat, light, and humidity. A critical issue stems from the residual strain that often develops within the perovskite film during conventional fabrication processes. This internal stress can lead to the formation of defects and degradation over time, limiting the operational lifespan of the devices.

Innovative Annealing with 1,4-Butanesultam Additive

To overcome this, recent research has introduced an innovative strategy involving the incorporation of a small amount of an organic additive, 1,4-butanesultam, into the perovskite precursor solution, followed by an optimized annealing (thermal treatment) process. This additive plays a crucial role in influencing the perovskite crystallization mechanism, leading to several key benefits:

- **Alleviation of Residual Strain:** 1,4-butanesultam helps mitigate the strain within the perovskite lattice during crystallization, promoting the formation of a more uniform and defect-free film. This reduction in internal stress significantly improves the device's resilience to external environmental factors.
- **Enhanced Crystal Quality:** The additive also contributes to a passivation effect at the grain boundaries, reducing charge recombination sites. This results in improved charge separation and transport efficiency, leading to higher open-circuit voltage (V_{oc}) and fill factor (FF).
- **Achieving High Efficiency:** Perovskite solar cells fabricated using this additive-assisted annealing method achieved an impressive PCE of 26.79%, a remarkably high value for single-junction perovskite devices.

Demonstrated Long-Term Stability and Future Prospects

The developed devices exhibited outstanding stability performance, evaluated according to the international ISOS-V-2 protocol:

- **Continuous Operation Stability:** The cells maintained 95% of their initial efficiency after 1,000 hours of continuous operation under simulated sunlight, representing a significant step towards practical, long-lived devices.
- **Cycling Stability:** Furthermore, negligible degradation was observed after 1,500 hours of daily cycling tests, which simulate the diurnal variations in temperature and light exposure. This outcome underscores the device's reliability under fluctuating outdoor conditions.

This additive-assisted annealing technology, utilizing 1,4-butanesultam, offers a powerful solution to the critical challenge of long-term stability for perovskite solar cells, a major barrier to their commercialization. Future work will focus on scaling this technology for large-area applications and verifying its cost-effectiveness, positioning it as a potential game-changer for the next-generation solar energy market.

Source: https://bioengineer.org/additive-assisted-annealing-boosts-perovskite-solar-stability/

Choosing Testing Equipment for Perovskite Solar Cell Pilot Lines: A Comprehensive Guide

Published May 26, 2026 Lecheng Intelligence Technology (Suzhou) Co., Ltd. China

OVERVIEW

Selecting appropriate testing equipment is critical for the quality and commercial success of perovskite solar cell pilot lines. This guide emphasizes comprehensive considerations across efficiency measurement, spectral response, long-term stability, environmental reliability, and data traceability. Implementing a robust testing system allows manufacturers to accurately understand process quality, improve module yield, and strengthen readiness for scalable commercial production. This investment is indispensable for advancing the maturity of perovskite technology.

IN DEPTH

The Crucial Role of Quality Control in Perovskite PV Manufacturing

As perovskite solar cell technology transitions from research and development to pilot production and eventual commercialization, quality control of the manufacturing process becomes paramount. For pilot lines, in particular, the selection of appropriate testing equipment is crucial for validating product performance, reliability, and reproducibility, which in turn dictates the success of future large-scale production. Inadequate testing systems can compromise data integrity, delay the identification of technical challenges, and ultimately lead to market entry delays and increased costs.

Key Considerations for Testing Equipment Selection

Lecheng Intelligence Technology recommends a comprehensive approach to selecting testing equipment for perovskite solar cell pilot lines, covering the following critical aspects:

- **Power Conversion Efficiency (PCE) Measurement:** Solar simulators and I-V measurement systems are the most vital tools for assessing basic cell performance. Accuracy, reproducibility, and compliance with international standards (e.g., IEC 61215/61646) are essential.
- **Spectral Response (EQE/IQE) Measurement:** Indispensable for understanding how efficiently devices utilize different wavelengths of light. This aids in optimizing material absorption characteristics and charge separation efficiency.
- **Long-Term Stability Testing:** Accelerated degradation testing equipment (e.g., constant temperature and humidity chambers, UV irradiation testers, thermal cycling chambers) is crucial for predicting device longevity under harsh conditions like high temperature, high humidity, UV exposure, and thermal cycling, thereby guaranteeing product reliability.
- **Environmental Reliability Testing:** Simulating outdoor installation, tests compliant with module safety standards like IEC 61730 (e.g., mechanical load, damp-heat, freeze-thaw, salt mist) are performed to evaluate robustness in real operational environments.

- **Data Management and Traceability:** All test data must be accurately recorded, analyzed, and managed. This enables the identification of manufacturing process improvements, root cause analysis of defects, and robust quality assurance.
- **Scalability and Flexibility:** It is important to choose equipment with the flexibility to accommodate various cell and module sizes, and with future upgrade paths, considering the transition from R&D to pilot production and eventual mass production.

Impact on Commercialization and Outlook

Strategic investment in these testing facilities is not merely a cost but a foundational step to ensure the commercial success of perovskite solar cells. By continuously acquiring high-quality and reliable data, manufacturers can quickly identify and resolve process bottlenecks, improve manufacturing consistency, and guarantee the quality of the final product. This builds customer trust and enhances market competitiveness. The implementation of appropriate testing systems is an indispensable step for perovskite technology to establish its position as a sustainable energy solution that can rival silicon.

Source: https://www.le-laser.com/news

Collected: May 30, 2026 | Automated Research System (Gemini API)

Perovskite Laser Scribing Equipment Buyer's Guide: Maximizing Production Efficiency Through Optimal Selection

Published May 25, 2026 Lecheng Intelligence Technology (Suzhou) Co., Ltd. China

OVERVIEW

Laser scribing equipment is crucial for enhancing module performance and yield in perovskite solar cell manufacturing. This guide offers detailed advice for buyers to avoid overinvestment or inadequate configurations. It emphasizes clarifying current R&D needs and future pilot production plans to select suitable equipment. Clear process information, sample testing, and precise equipment configuration are highlighted as essential for maximizing long-term production efficiency and cost-effectiveness.

IN DEPTH

The Critical Role of Laser Scribing Technology

In the manufacturing of perovskite solar cell modules, the "scribing" process—electrically separating individual cells and connecting them in series—is indispensable. High-precision laser processing is particularly critical for perovskite films, which are thin and typically multi-layered. Traditional mechanical scribing methods often lead to micro-cracks or material scattering, risking degraded device performance and reduced yield. Laser scribing technology overcomes these issues by enabling non-contact, high-definition processing.

Key Points for Equipment Purchase

Lecheng Intelligence Technology advises companies considering the purchase of perovskite laser scribing equipment to consider the following aspects:

- **Clarify Application:** Define whether the equipment will be used for R&D, pilot production, or future mass production lines. Flexibility and versatility are prioritized for R&D, while speed, stability, and automation are key for mass production.
- **Understand Process Requirements:** Optimal laser wavelength, pulse width, power, and processing speed vary depending on the perovskite composition, film thickness, and stack structure. Close collaboration with the supplier to identify the best processing conditions for your specific material stack is essential.
- **Conduct Sample Testing:** It is crucial to perform actual laser processing tests using your own material samples before purchasing. This allows for objective evaluation of processing quality, precision, and reproducibility, ensuring the expected performance can be achieved.
- **Alignment Accuracy and Positioning System:** High-precision alignment systems are indispensable for accurately scribing multi-layered structures. Selecting equipment with micrometer-level positioning accuracy and fast, precise module handling capabilities contributes significantly to yield improvement.
- **Software and Control System:** Intuitive and user-friendly software, along with a flexible programmable control system, reduces operator burden and facilitates adaptation to various processing patterns. Data collection and analysis capabilities are also important.

- **Future Scalability:** As perovskite technology evolves rapidly, choosing modular equipment that is easy to upgrade or adapt to future material changes and process improvements will enhance long-term return on investment.

Benefits of Optimal Equipment Selection

By following these guidelines and selecting laser scribing equipment that aligns with their specific needs, companies can optimize manufacturing costs, improve production efficiency, and ultimately enhance the reliability and performance of their final products. Collaborating with suppliers who possess both expertise in laser processing and deep knowledge of perovskite manufacturing is crucial for overcoming technical challenges and facilitating smooth integration, thereby accelerating the commercialization of perovskite solar cells.

Source: https://www.le-laser.com/news

Collected: May 30, 2026 | Automated Research System (Gemini API)

Building a Complete Perovskite Module Manufacturing Line: A Comprehensive Guide

Published May 24, 2026 Lecheng Intelligence Technology (Suzhou) Co., Ltd. China

OVERVIEW

The commercialization of perovskite solar cell modules necessitates meticulous planning of the entire manufacturing line, from substrate preparation to final testing. This guide emphasizes the importance of designing the full workflow to mitigate risks and accelerate scale-up. Optimal suppliers should not only provide equipment but also offer process integration support, aiding long-term commercialization. This ensures efficient, high-quality mass production of modules.

IN DEPTH

Transitioning to Commercial Production of Perovskite Solar Cells

While perovskite solar cells have demonstrated remarkable efficiencies at the laboratory scale, their mass production into large-area modules at low cost and with high reliability requires the establishment of comprehensive and efficient manufacturing lines. Given their unique material properties and processing requirements, which differ from conventional solar cell manufacturing, meticulous planning and specialized expertise are essential. Lecheng Intelligence Technology outlines the key steps and considerations for building a complete perovskite module manufacturing line.

Key Steps in Manufacturing Line Construction

An efficient and robust perovskite module manufacturing line must seamlessly integrate the following primary production stages:

- **Substrate Preparation:** This foundational step involves cleaning and surface treatment of glass or flexible substrates, and the formation of conductive layers. Uniformity and cleanliness are critical for high-quality module production.
- **Functional Layer Deposition:** Techniques for uniformly depositing each functional layer, including the electron transport layer (ETL), perovskite active layer, and hole transport layer (HTL). Slot-die coating, blade coating, vacuum deposition, and printing technologies are applied. Challenges include large-area uniformity, precise film thickness control, and defect suppression.
- **Electrode Formation:** This stage involves the creation of transparent conductive electrodes and metal electrodes. High-precision laser patterning (scribing) for series connection of cells is also included here.
- **Encapsulation:** Perovskite materials are sensitive to moisture and oxygen, making robust encapsulation crucial for long-term stability. Selecting appropriate materials like glass, EVA, polyolefin resins, and barrier films, along with optimized processes, is vital.
- **Quality Control and Testing:** In-line and off-line testing to ensure the quality of each manufacturing stage and the final product. This includes I-V characteristic measurements, EL/PL inspection, and long-term reliability tests (e.g., Damp-Heat, Thermal Cycling, UV irradiation).

- **Module Assembly and Framing:** The process of assembling completed cells into desired sizes and attaching frames. Special applications like Building-Integrated Photovoltaics (BIPV) require flexible assembly tailored to specific designs.

Importance of Process Integration and Supplier Selection

The success of a perovskite module manufacturing line hinges not just on the performance of individual equipment but on how efficiently they are integrated to function as a cohesive whole. Understanding the interactions between each process step and designing the workflow to minimize bottlenecks is crucial. Lecheng Intelligence Technology emphasizes the following points:

- **Comprehensive Workflow Design:** Designing the entire manufacturing process from the initial stage reduces future risks and enables smooth scale-up.
- **Collaboration with Suppliers:** Equipment vendors should ideally offer not only hardware but also deep knowledge in perovskite material science, process know-how, and integrated solutions. The supplier's expertise is essential for process optimization and troubleshooting.

Future Outlook

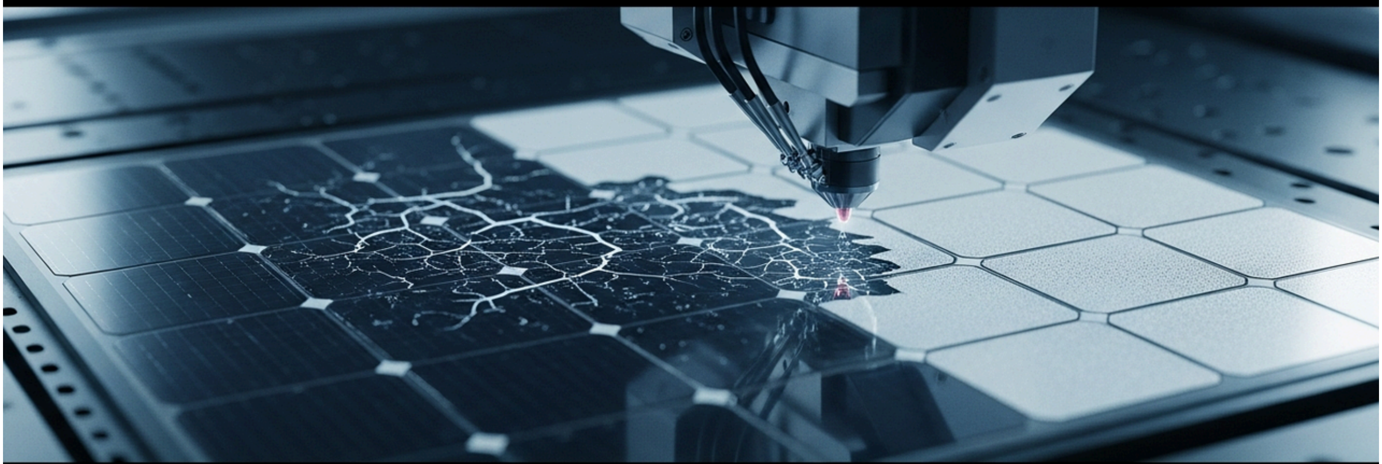
Perovskite solar cells hold significant potential as a complement or alternative to silicon photovoltaics. The commercialization of this technology depends on the maturity of its manufacturing processes, specifically the ability to consistently supply high-quality modules at low cost. The establishment of appropriate manufacturing lines is a decisive step for this next-generation technology to secure a strong position in the energy market.

Source: https://www.le-laser.com/news

Collected: May 30, 2026 | Automated Research System (Gemini API)

Common Pitfalls and Solutions When Purchasing Perovskite Laser Processing Equipment

Published May 23, 2026 Lecheng Intelligence Technology (Suzhou) Co., Ltd. China



OVERVIEW

Implementing laser processing equipment for perovskite solar cell manufacturing is crucial for module performance and production efficiency. However, common pitfalls include prioritizing price, vague process requirements, overlooking material compatibility, underestimating alignment accuracy, and neglecting future upgrade needs. This article details these mistakes, emphasizing the importance of sharing clear process information and collaborating with suppliers knowledgeable in both laser processing and perovskite module manufacturing.

IN DEPTH

Challenges of Laser Processing in Perovskite Solar Cell Manufacturing

In the production of perovskite solar cell modules, laser processing is a critical precision technology indispensable for serial cell interconnection, electrode patterning, and specific structural formation. While the selection of laser processing equipment is paramount for manufacturing high-efficiency and stable modules, its inherent complexity often leads to significant purchasing mistakes. These errors can result in suboptimal performance, production delays, and unexpected cost increases.

Common Mistakes to Avoid During Purchase

Lecheng Intelligence Technology highlights common pitfalls to be aware of when acquiring perovskite laser processing equipment, offering insights to circumvent them:

- **Focusing Solely on Price:** Concentrating solely on a low initial purchase cost can lead to overlooking larger issues such as long-term operating costs, maintenance expenses, reduced productivity, and compromised product quality. It is crucial to evaluate the total cost of ownership (TCO) and long-term return on investment (ROI).
- **Unclear Process Requirements:** Optimal laser wavelength, pulse width, power, and scanning speed vary significantly depending on the perovskite composition, film thickness, stack structure, and target processing patterns (e.g., P1, P2, P3). Failure to clearly communicate these requirements to the supplier will result in suboptimal solutions.
- **Ignoring Material Stack Compatibility:** The interaction between the laser and the perovskite material, as well as underlying transparent conductive oxides (TCOs) and buffer layers, is complex. An inappropriate laser wavelength or energy can damage underlying layers or cause undesirable thermal effects. Pre-purchase testing on your specific material stack is essential.
- **Underestimating Alignment Accuracy:** Especially for scribing multi-layered structures, micro-level precision alignment is required. Poor alignment accuracy can lead to damage to adjacent layers, electrical shorts, and efficiency reduction. The equipment's vision system and positioning accuracy must be rigorously evaluated.

- **Neglecting Future Upgrade Needs:** Perovskite technology is evolving rapidly. It is prudent to choose equipment with a modular and flexible design that can accommodate not only current requirements but also future changes in materials or processes and scaling up production.
- **Supplier's Lack of Expertise:** Even experts in laser technology may not be conversant with the specific challenges of perovskite solar cell manufacturing. Selecting a supplier with proven expertise in both fields offers significant advantages in technical support and troubleshooting.

Optimal Purchasing Strategy and Outlook

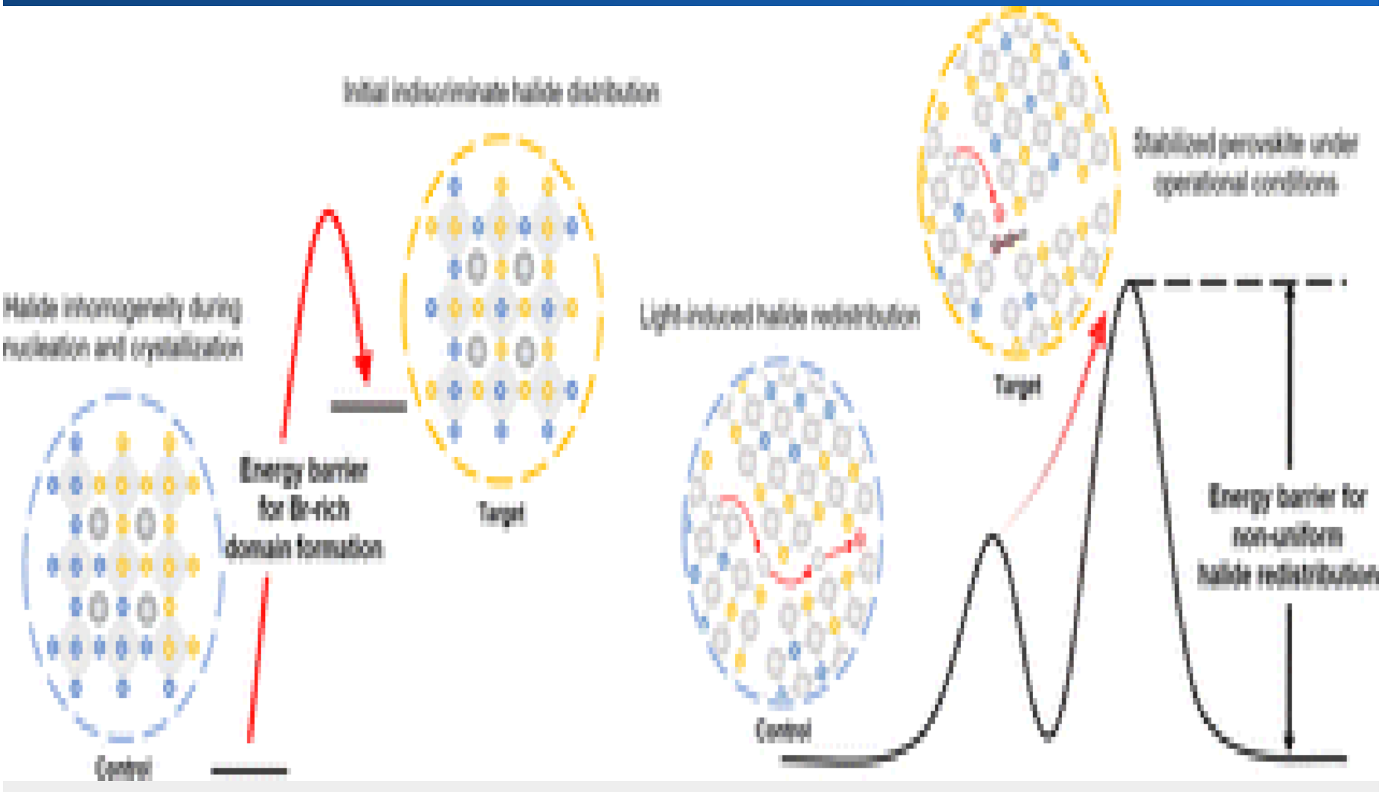
To avoid these mistakes, purchasers must possess a deep understanding of their own manufacturing processes and materials, beyond just equipment specifications. Furthermore, close collaboration with the supplier from the initial stages, sharing detailed process requirements, and thorough evaluation with actual materials are critical. The right laser processing equipment is a vital investment for enhancing the efficiency, stability, and cost-effectiveness of perovskite solar cell modules, thereby accelerating the commercialization of this innovative technology.

Source: https://www.le-laser.com/news

Collected: May 30, 2026 | Automated Research System (Gemini API)

Thermodynamic Inhibition of Bromine-Rich Phase Nucleation Drives Highly Stable Wide-Bandgap Perovskite Tandem Solar Cells to Record Efficiencies

Published May 30, 2026 Energy & Environmental Science (RSC Publishing) UK



OVERVIEW

This research addresses the operational instability of wide-bandgap perovskites, critical for high-efficiency tandem solar cells, identifying preferential nucleation of bromine-rich phases during film formation as a root cause. A novel thermodynamic inhibition strategy achieved 23.50% PCE for 1.68 eV single-junction devices, maintaining 98% efficiency over 2240 hours. A perovskite-silicon tandem cell reached a certified 32.52% PCE with an extrapolated T90 lifetime exceeding 9700 hours, demonstrating exceptional operational stability crucial for commercial viability.

IN DEPTH

Stability Challenges in Wide-Bandgap Perovskites

Perovskite solar cells are garnering significant attention as a next-generation photovoltaic technology due to their outstanding power conversion efficiencies. Specifically, wide-bandgap perovskites are essential components for achieving even higher overall efficiencies in tandem architectures when combined with conventional silicon solar cells. However, these materials are prone to light-induced halide phase segregation, where the halide composition becomes non-uniform under illumination, leading to operational instability. The formation of bromine-rich phases, in particular, has been identified as a direct cause of device performance degradation.

Thermodynamic Inhibition Strategy for Enhanced Stability

This study elucidated that the preferential nucleation of bromine-rich phases during the film formation process is the fundamental mechanism driving the intrinsic compositional inhomogeneity in wide-bandgap perovskites. To counteract this, the research team developed a novel 'thermodynamic inhibition' approach. This strategy precisely controls the perovskite layer's crystal growth to intentionally suppress the nucleation of these undesirable bromine-rich phases.

- **1.68 eV Single-Junction Devices:** Applying this thermodynamic inhibition strategy, the researchers fabricated 1.68 eV wide-bandgap single-junction perovskite solar cells that achieved a high power conversion efficiency of 23.50%. Furthermore, in long-term operational stability tests, these devices maintained 98% of their initial efficiency over 2240 hours, a remarkable result that significantly enhances the reliability of single-junction devices.
- **Perovskite-Silicon Tandem Cells:** When this stabilized wide-bandgap perovskite was used as the top cell in a tandem structure with a silicon bottom cell, it achieved an extraordinary efficiency of 33.08% (certified at 32.52% by an independent third party). This level of efficiency approaches the current records for solar cells. Moreover, the tandem devices maintained their performance after 540 hours of outdoor operation, with an extrapolated T90 lifetime (time to 90% of initial efficiency) exceeding 9700 hours, demonstrating exceptional operational stability.

Technical Significance and Outlook

This research presents a groundbreaking thermodynamic solution to the problem of light-induced phase segregation in wide-bandgap perovskites, removing one of the largest barriers to the commercialization of tandem solar cells. The simultaneous achievement of high efficiency and superior long-term stability represents a decisive advance in the development of practical next-generation solar cells. While challenges such as large-area scaling and manufacturing cost reduction remain, this achievement significantly boosts the potential for perovskite solar cells to become a competitive option in the energy market.

Source: https://pubs.rsc.org/en/content/articlelanding/2026/ee/d5ee06815k

Collected: May 30, 2026 | Automated Research System (Gemini API)

Chinese Researchers Achieve World Record 30.3% Efficiency for All-Perovskite Tandem Solar Cells

Published May 24, 2026 Knowridge China

OVERVIEW

Researchers at the Ningbo Institute of Materials Technology and Engineering (NIMTE) in China have achieved a certified world-record efficiency of 30.3% for rigid all-perovskite tandem solar cells. Furthermore, their flexible counterparts reached an impressive 28.0% PCE, signifying a major leap toward practical, lightweight, and versatile next-generation solar cells. Published in Nature Nanotechnology, this breakthrough leverages the hard-soft acid-base theory to homogenize crystal formation, addressing manufacturing challenges and accelerating sustainable energy deployment.

IN DEPTH

World Record Efficiency for All-Perovskite Tandem Solar Cells

Perovskite solar cells are a leading research focus in the energy sector due to their excellent power conversion efficiency and potential for low-cost manufacturing. Specifically, "all-perovskite tandem solar cells," which stack two perovskite layers, are expected to achieve even higher efficiencies by capturing a wider range of the solar spectrum than single perovskite cells. A team of scientists from the Ningbo Institute of Materials Technology and Engineering (NIMTE), Chinese Academy of Sciences, has announced a groundbreaking achievement in this field.

Innovative Technology and Achieved Efficiencies

NIMTE researchers developed a new approach to precisely control the crystallization process of perovskite layers. They applied the "Hard-Soft Acid-Base (HSAB) theory" to select additives for perovskite crystal growth, enabling the formation of more uniform and high-quality films. This technological innovation resulted in the following record-breaking efficiencies:

- **World Record for Rigid Cells:** In rigid all-perovskite tandem solar cells, a world-record power conversion efficiency (PCE) of 30.3% was achieved and independently certified. This performance is comparable to or even surpasses that of silicon-based tandem cells.
- **High Efficiency for Flexible Cells:** Applying similar technology, flexible all-perovskite tandem cells recorded a high PCE of 28.0%. This significantly expands the possibilities for lightweight, bendable solar cells.

This HSAB theory-based approach provides new guidelines for material selection and process parameter optimization, contributing to overcoming large-scale manufacturing challenges by improving the uniformity and stability of perovskite films.

Impact and Future Outlook

This research, published in Nature Nanotechnology, represents a significant step towards the commercialization of perovskite solar cells. An efficiency exceeding 30% suggests that perovskite technology is competitive not only in terms of cost but also performance compared to conventional solar cell technologies. The achievement of high efficiency in flexible devices will accelerate their deployment in diverse applications such as Building-Integrated Photovoltaics (BIPV), wearable devices, and mobile power sources. The research team aims for this technology to promote the adoption of clean energy and provide more affordable and practical solar power solutions, contributing to the realization of a sustainable society.

Source: https://www.thecooldown.com/green-tech/perovskite-solar-technology-china-breakthrough/

Renshine Solar and Jingling Technology Form Strategic Alliance for Advanced Perovskite Material Development, Targeting Space Applications

Published May 24, 2026   Perovskite-Info   China

OVERVIEW

Chinese perovskite solar cell developer Renshine Solar has announced a strategic cooperation agreement with Jingling Technology, a specialist in perovskite materials. This partnership focuses on co-developing high-performance perovskite materials, including ultra-high purity microcrystalline substances and fullerene compounds. The alliance aims to build an integrated innovation platform spanning core materials to cell technology and module applications, accelerating the large-scale deployment of perovskite technology, particularly for utility-scale solar farms and next-generation space-based photovoltaics.

IN DEPTH

Strategic Alliance for Perovskite Technology in China

Perovskite solar cell technology is undergoing intense research and development globally, with China leading many initiatives, driven by its high power conversion efficiency and potential for reduced manufacturing costs. Renshine Solar, one of China's leading perovskite solar cell developers, has now announced a strategic cooperation agreement with Jingling Technology, a company specializing in perovskite materials. This alliance aims to strengthen the entire perovskite supply chain within China and resolve technological bottlenecks hindering commercialization.

Key Aspects of the Partnership and Technical Focus

The collaboration between Renshine Solar and Jingling Technology will primarily focus on the development of high-performance perovskite materials. Specifically, cooperation will be advanced in the following areas:

- **Development of Ultra-High Purity Microcrystalline Substances:** The quality of the perovskite layer heavily depends on the purity and crystallinity of the precursor materials used. By combining Jingling Technology's expertise in material science with Renshine Solar's device development experience, they aim to optimize microcrystalline substances to maximize the stability and efficiency of perovskite films.
- **Application of Fullerene Compounds:** Fullerene compounds, used as electron or hole transport layers or as additives in the perovskite layer, play crucial roles in carrier transport and device stability. Both companies will jointly research improvements in the performance of these compounds and their suitability for perovskite devices.
- **Establishment of an Integrated Innovation Platform:** This partnership extends beyond mere material supply, aiming to build a platform that comprehensively integrates research and development of core materials, innovative cell design, and final module applications. This will accelerate the technology development cycle and enable rapid market entry.

Prospects for Large-Scale Applications and Space Photovoltaics

The ultimate goal of this strategic alliance is the large-scale practical application of perovskite solar cells. Specific application areas envisioned include:

- **Utility-Scale Solar Farms:** By resolving challenges related to large-area scalability and long-term stability, the partnership aims to promote the introduction of perovskite technology as an alternative or complement to silicon-based solar cells in large-scale ground-mounted solar power plants.
- **Next-Generation Space Photovoltaic Systems:** The lightweight, flexible, and high-efficiency characteristics of perovskite solar cells make them exceptionally suitable for use in space environments. Both companies will also focus on developing materials for next-generation space photovoltaic systems to be deployed on spacecraft and satellites, supporting innovation in China's aerospace technology sector.

This partnership marks a significant step for China in establishing global leadership in perovskite solar cell technology and providing sustainable energy solutions worldwide. The integration of material development and device application is expected to dramatically accelerate the commercialization of perovskite technology.

Source: https://www.perovskite-info.com/renshine-solar-partners-jingling-technology-perovskite-materials

Collected: May 30, 2026 | Automated Research System (Gemini API)

Enecoat Technologies Targets 2035 Commercial Launch for Space-Grade Flexible Perovskite Solar Cells

Published May 25, 2026   RYOEX   Japan

OVERVIEW

Enecoat Technologies, a Japanese startup spun out of Kyoto University, aims to commercialize thin, flexible perovskite solar cells for space applications by 2035. Their technology, selected for a JAXA space strategy fund project, is lauded for its lightweight and high efficiency, ideal for harsh orbital environments. Enecoat's cells are over ten times lighter than silicon counterparts, achieve over 20% PCE in small formats, and are slated for initial production of small cells for wearable devices at a new Uji factory in 2027.

IN DEPTH

The Promise of Perovskite Solar Cells in Space

For space missions and satellite power generation, lightweight and highly efficient solar cells are constantly sought after. Traditional silicon-based solar cells are heavy, rigid, and impose constraints on rocket launch costs and deployment. In response to these challenges, perovskite solar cells are garnering significant attention as a next-generation power source for space, owing to their thin, lightweight, and flexible characteristics. Enecoat Technologies, a Japanese startup, is making headlines with its concrete commercialization targets in this field.

Enecoat Technologies' Strategy and Technology

Enecoat Technologies, built on perovskite technology cultivated at Kyoto University, is pursuing an ambitious plan to commercialize space-grade perovskite solar cells by 2035. Their technology has been adopted by the Japan Aerospace Exploration Agency (JAXA) for its "Space Strategic Fund Project," underscoring its high technical merit.

- **Exceptional Lightweight Property:** Enecoat's perovskite solar cells can reduce weight by more than tenfold compared to silicon-based solar cells producing equivalent power. This is a critical factor for significantly cutting rocket launch fuel requirements and enhancing spacecraft payload capacity.
- **High Efficiency and Flexibility:** Achieving over 20% power conversion efficiency in small cells, they can generate power efficiently in the confined spaces of orbit. Furthermore, their flexible nature allows for application on complex curved surfaces and deployable structures, increasing satellite design freedom.
- **Adaptation to Harsh Space Environments:** Space is characterized by extreme temperature fluctuations, high-energy particle radiation, and vacuum conditions. Enecoat is focusing on developing materials, device structures, and encapsulation techniques to ensure durability under these demanding environments.

Commercialization Roadmap and Future Developments

Before direct space application, Enecoat Technologies plans to mature its technology through terrestrial product deployment. The company is set to launch a new factory in Uji, Kyoto Prefecture, in 2027, where it will begin production of small perovskite solar cells for wearable devices such as smartwatches. By building a track record with these products, Enecoat aims to establish mass production technology and reliability, gradually entering the space market. Space-grade perovskite solar cells are expected to open new possibilities in space exploration, Earth observation satellites, and communication satellites, while also contributing to strengthening Japan's competitiveness in the space industry.

Source: https://www.ryoex.com/en/market-news/20260524181387/

NTU Singapore Develops Ultra-Thin Transparent Perovskite Solar Cells for Seamless Integration into Windows and Facades

Published May 26, 2026 New Atlas Singapore

OVERVIEW

Researchers at Nanyang Technological University (NTU) Singapore have developed ultra-thin transparent perovskite solar cells, approximately 50 times thinner than conventional devices, achieving leading efficiencies in their category. Published in ACS Energy Letters, this vacuum-based thermal evaporation technology holds potential to transform building windows, glass facades, and vehicle sunroofs into power-generating surfaces. These color-neutral devices can generate electricity even under diffuse light, offering a groundbreaking solution to urban photovoltaic installation constraints.

IN DEPTH

New Frontier for Urban Photovoltaics

In urban areas, the widespread deployment of conventional opaque solar panels has been limited by land scarcity and the need to maintain building aesthetics. To overcome these challenges, transparent or semi-transparent solar cells offer significant potential to convert underutilized spaces like building windows and facades into power-generating surfaces. A research team at Nanyang Technological University (NTU) in Singapore has made a breakthrough in this field, successfully developing highly practical ultra-thin, semi-transparent perovskite solar cells.

NTU's Innovative Technology and Device Characteristics

The perovskite solar cells developed by NTU researchers are unique and high-performing in several aspects:

- **Ultra-Thin Design:** The devices achieve an astonishing thinness, approximately 50 times thinner than typical conventional solar cells. This significantly facilitates their integration into existing window panes and other transparent materials without major structural modifications.
- **High-Efficiency Transparency:** While being semi-transparent, these cells achieve leading power conversion efficiencies (PCEs) within their category. This allows for effective electricity generation while still permitting natural light to enter indoor spaces.
- **Vacuum Thermal Evaporation Process:** The manufacturing process employs vacuum-based thermal evaporation. This method enables precise control over film thickness and uniform deposition, which is crucial for forming high-quality perovskite layers with reproducible properties.
- **Color-Neutral Appearance:** The developed devices are color-neutral, meaning they do not significantly alter the hue of transmitted light. This is a vital characteristic for Building-Integrated Photovoltaic (BIPV) applications, where architectural aesthetics and harmony with the existing landscape are paramount.

- **Power Generation Under Diffuse Light:** The cells possess the remarkable ability to generate electricity efficiently not only under direct sunlight but also under diffuse light conditions, such as on cloudy days or from indoor lighting. This adaptability is advantageous for maximizing power output in diverse urban lighting environments.

Broadening Applications and Future Outlook

The findings for these ultra-thin, semi-transparent perovskite solar cells have been published in "ACS Energy Letters," indicating their broad range of potential applications:

- **BIPV Applications:** They can transform building windows, glass facades, and skylights into smart, power-generating elements. This will contribute to increasing a building's energy self-sufficiency and achieving net-zero energy buildings.
- **Vehicle Applications:** The cells can be integrated into vehicle windows, sunroofs of cars and trains, potentially serving as auxiliary power sources or extending driving range for electric vehicles.
- **Portable Devices:** Given their lightweight and flexible nature, integration into smart devices and IoT sensors is also anticipated, providing a continuous power supply.

NTU's research offers a fundamental solution to the spatial constraints of photovoltaic installations in urban areas and represents a crucial step towards realizing future smart cities and sustainable architecture. Future efforts will focus on further large-area scalability, long-term durability, and cost-effectiveness.

Source: https://newatlas.com/energy/transparent-solar-cells-windows/

Sekisui Chemical Pours ¥100 Billion into Flexible Perovskite Solar, Targeting 2028 Profitability

Published Published May 26, 2026 積水化学工業 Japan

OVERVIEW

Sekisui Chemical Co., Ltd. has unveiled a substantial ¥100 billion strategic investment into its flexible perovskite solar cell business, a cornerstone of its new 'Accelerate 2028' medium-term management plan. The Japanese chemical giant aims to achieve over ¥25 billion in sales from this segment and turn a profit by fiscal year 2028, signaling a decisive move to accelerate mass production and secure leadership in the next-generation solar market.

IN DEPTH

Background

Sekisui Chemical Co., Ltd., a prominent Japanese chemical manufacturer, is strategically realigning its focus towards environmental and life sciences sectors. Leveraging its extensive technological portfolio, the company aims to contribute significantly to a sustainable society. Its recently unveiled medium-term management plan, 'Accelerate 2028,' concretely manifests this strategy, with a particular emphasis on a substantial investment in its flexible perovskite solar cell business.

Key Findings

Sekisui Chemical has earmarked a substantial strategic investment of ¥100 billion (approximately $640 million USD*) for its flexible perovskite solar cell business, positioning it as a pivotal future growth engine. This considerable capital injection is designed to achieve several critical objectives:

- **Business Profitability and Sales Targets:** The company aims to generate over ¥25 billion (approximately $160 million USD*) in sales from its flexible perovskite solar cell division and achieve profitability by fiscal year 2028. This ambitious target signifies a critical transition for perovskite technology, moving it decisively from an intensive R&D phase towards a robust, revenue-generating commercial enterprise.
- **Establishment of Mass Production Technology:** A substantial share of the investment will be channeled into establishing advanced mass production capabilities for flexible perovskite solar cells. This encompasses crucial advancements in enhancing conversion efficiency, guaranteeing long-term operational stability, dramatically scaling up the production area, and developing and implementing highly cost-effective manufacturing processes. Sekisui Chemical's deep expertise in film technology and polymer materials is anticipated to provide a significant competitive edge in accelerating these developments.

- **Expansion into Diverse Markets:** The inherent lightweight and flexible nature of film-type perovskite solar cells unlocks installation opportunities in myriad locations where conventional rigid solar panels are impractical or aesthetically unfeasible. These include building facades, windows, corrugated metal roofs of industrial facilities, vehicles, and a wide array of Internet of Things (IoT) devices. This versatility positions Sekisui Chemical to penetrate emerging markets such as Building-Integrated Photovoltaics (BIPV), novel mobility applications, and various off-grid power solutions, catering to a broader spectrum of energy needs.

Sekisui Chemical's strategic investment is projected to significantly accelerate the widespread adoption of renewable energy, directly combating global warming. By delivering highly efficient and environmentally responsible next-generation solar cells, the company aims to contribute substantially to achieving global CO_2 emission reduction targets and fostering a sustainable society. With this investment, Sekisui Chemical aspires to establish a dominant leadership position in the burgeoning perovskite solar cell market and play a pivotal role in the global energy transition beyond 2030. The immediate focus will now shift to expediting technological development, solidifying robust production systems, and ensuring rapid market introduction.

**Note: USD conversions are approximate based on recent exchange rates and subject to fluctuation.*

Source: https://www.sekisui.co.jp/ir/library/document/management_plan/

China Launches Perovskite Solar Cells into Space Aboard Shenzhou-23 for In-Orbit Testing

Published May 25, 2026 Shanghai Metals Market (SMM PV) China

OVERVIEW

China launched the Shenzhou-23 manned spacecraft on May 24, 2026, initiating in-orbit testing of perovskite solar cells in the space environment. Over a six-month mission, the low-cost, ultra-thin, high-efficiency third-generation PV cells will be evaluated for efficiency degradation, radiation resistance, stability, and adaptability to extreme temperature cycling. This experiment marks a critical step in assessing the industrialization potential of perovskite technology in harsh extraterrestrial conditions.

IN DEPTH

The Promise of Perovskite Solar Cells in Space

The success of space missions heavily relies on robust and reliable power supply systems. While conventional space solar cells have primarily been based on inorganic semiconductors like silicon and gallium arsenide, these materials present challenges in terms of weight and manufacturing cost. Perovskite solar cells, with their lightweight, thin, flexible nature, and potential for high conversion efficiency, are garnering global attention as a next-generation power source for space. China has taken concrete steps to establish leadership in the space application of this cutting-edge technology.

Shenzhou-23 Mission and In-Orbit Testing

On May 24, 2026, China successfully launched the Shenzhou-23 manned spacecraft. As one of the critical payloads for this mission, perovskite solar cells were onboard, commencing their long-term in-orbit testing. This space experiment, scheduled to last approximately six months, aims to thoroughly verify the following key performance parameters:

- **Evaluation of Efficiency Degradation:** Measuring how the power conversion efficiency of perovskite cells changes under the intense sunlight, UV radiation, and high-energy particle bombardment of the space environment.
- **Verification of Radiation Resistance:** Space radiation is a factor that rapidly degrades the performance of semiconductor devices. The experiment will assess perovskite's durability against radiation and confirm its structural stability.
- **Long-Term Stability:** Monitoring the physical and electrical stability of the cells under harsh conditions such as vacuum and extreme temperature fluctuations (hundreds of degrees Celsius due to the spacecraft's day-night cycles).
- **Adaptability to Temperature Cycling:** Evaluating the impact of frequent temperature increase and decrease cycles in orbit on the interfaces of the perovskite layers, electrodes, and encapsulants.

Impact on Space Industrialization and Outlook

This in-orbit testing aboard Shenzhou-23 represents a crucial milestone for the industrialization of perovskite solar cells for space applications. If these tests yield positive results, it could open possibilities for providing lighter, lower-cost, and more efficient power supply solutions for future satellites, space stations, deep-space probes, and even lunar bases. This is expected to offer numerous benefits in space development, including reduced launch costs, increased payload capacity, and extended mission durations. China, through this technology, aims to further enhance its competitiveness in space development and advance a new era of space utilization.

Source: https://news.metal.com/en/newscontent/103919658-SMM-PV-Perovskite-Cells-Launched-into-Space

Collected: May 30, 2026 | Automated Research System (Gemini API)

Beyond Light Management: Unveiling the Multifaceted Advantages of Nano- and Micro-Textures in Perovskite Solar Cells

Published May 29, 2026 arXiv Global/USA

OVERVIEW

This paper reviews the diverse benefits of nano- and micro-textures in perovskite solar cells, extending beyond mere light management. Key advantages include improved wettability of perovskite solutions, enhanced crystallinity (grain size, crystal orientation, phase homogeneity), bolstered carrier extraction leading to higher open-circuit voltage, and increased mechanical stability for flexible devices. The research suggests that textured surfaces offer comprehensive performance improvements across perovskite-based solar cells, photodetectors, and light-emitting diodes.

IN DEPTH

Re-evaluating Surface Textures in Perovskite Solar Cells

Performance enhancements in perovskite solar cells have been pursued from both material science and device architecture perspectives. While surface texturing has been extensively studied for its ability to improve light capture efficiency through "light management," this review systematically presents that nano- and micro-scale textures offer a wide array of significant benefits beyond just light management. This new perspective suggests novel directions for the design and optimization of perovskite devices.

Multifaceted Functions of Nano- and Micro-Textures

This paper details how surface textures positively influence multiple properties of perovskite devices:

- **Improved Film Wettability:** Textured substrates enhance the wettability of perovskite precursor solutions, promoting more uniform film formation. This enables the fabrication of high-quality perovskite layers with fewer defects, which is crucial for device performance.
- **Enhanced Crystallinity:** Texturing influences the growth of perovskite crystals, contributing to optimized grain size, inducing desirable crystal orientation, and improving compositional phase homogeneity. These factors directly impact carrier generation and transport efficiency.
- **Boosted Carrier Extraction:** Optimal texture design aids in efficiently extracting electrons and holes, generated within the perovskite layer, to their respective transport layers. This reduces carrier recombination and leads to an increase in open-circuit voltage (V_{OC}).
- **Improved Mechanical Stability:** Especially in flexible perovskite solar cells, substrate texturing has been shown to enhance the device's resilience against mechanical stresses such as bending and stretching. This is vital for ensuring the long-term durability and reliability of the device.

- **Applications Beyond Optical Function:** These benefits are not limited to increasing light absorption efficiency in solar cells but also potentially lead to comprehensive performance improvements in other perovskite-based optoelectronic devices, such as photodetectors and light-emitting diodes (LEDs).

Future Research and Industrial Impact

This review emphasizes that in the design of perovskite devices, surface textures should be considered as multifunctional elements that impact material, electrical, and mechanical properties synergistically, rather than merely as light management tools. Future research will likely focus on further exploring optimal texture patterns and fabrication methods for specific application areas. This approach is expected to accelerate the commercialization of perovskite technology and contribute to the realization of higher-performance, more reliable next-generation optoelectronic devices.

Source: https://arxiv.org/abs/2605.30182v1

Mitigating Potential-Induced Degradation in Perovskite Photovoltaics Through Positive-Voltage System Architectures

Published May 27, 2026 ACS Energy Letters (ACS Publications) USA

OVERVIEW

Perovskite solar cells are vulnerable to potential-induced degradation (PID), posing a significant challenge to their long-term reliability. This study demonstrates that PID in encapsulated inverted perovskite solar cells can be effectively mitigated using positive-voltage systems. Devices maintained over 95% of their initial power output after 168 hours under positive bias, meeting commercial module certification standards. This indicates that PID is manageable at the system level, relaxing cell and module design constraints.

IN DEPTH

The Challenge of Potential-Induced Degradation (PID) in Perovskite Solar Cells

Despite rapid technological advancements in perovskite solar cells, long-term reliability and durability remain critical concerns, with Potential-Induced Degradation (PID) being one of the primary culprits. PID is triggered by a combination of voltage bias across the solar module and environmental factors (e.g., temperature, humidity), which can lead to power loss and premature failure. While also observed in conventional silicon solar cells, perovskites' inherent ionic migration properties have made them particularly vulnerable to PID.

Positive-Voltage System Strategy for PID Mitigation

This research experimentally demonstrated that PID in perovskite solar cells can be effectively mitigated by implementing positive-voltage systems—i.e., systems designed such that the overall module voltage bias with respect to ground is positive. The study specifically focused on encapsulated inverted (p-i-n structure) perovskite solar cells, yielding significant insights and results:

- **Understanding the Mechanism:** It is hypothesized that when a positive voltage is applied, the accumulation of charges at defect states within the perovskite layer and interfaces is suppressed, stabilizing ion migration. This mechanism delays or halts the progression of degradation reactions.
- **Superior Stability Demonstrated:** The research team continuously tested encapsulated perovskite solar cells under positive voltage conditions for 168 hours. During this period, the devices maintained over 95% of their initial power output, showing minimal degradation. This performance aligns with the stringent certification standards for PID resistance that commercial solar modules must meet.
- **Impact on Practical Applications:** This finding strongly suggests that PID is manageable not only at the material level of the cell or module but also through system-level design and operation. This increases the flexibility in installation design for perovskite solar cells, enabling broader applications.

Technical Significance and Future Outlook

This research represents a crucial breakthrough for improving the long-term reliability of perovskite solar cells, significantly accelerating their path to commercialization. By demonstrating that PID can be overcome through optimized system design, it potentially relaxes some stringent constraints on the chemical composition and device structure of perovskite materials themselves. Future research will focus on verifying applicability to various types of perovskite solar cell modules, long-term field testing under different environmental conditions, and evaluating PID behavior in actual grid-connected systems. This technology is indispensable for establishing the reliability needed for perovskite solar cells to become a widely adopted primary renewable energy source.

Source: https://pubs.acs.org/doi/10.1021/acsenergylett.6c00520

From Lab Promise to Product Reality: Navigating Challenges and Progress in Perovskite Photovoltaics Commercialization

Published May 26, 2026 Nature Reviews Clean Technology UK

OVERVIEW

This review extensively discusses the challenges and advancements in transitioning perovskite solar cells from high-efficiency laboratory devices to large-scale module products. It emphasizes that uniform functional films and optimized interfaces are crucial for high efficiency, while industrial efforts in stability, scribing, and encapsulation technologies are driving commercialization. Close collaboration between scientific research and industry is key to accelerating the market introduction of this groundbreaking technology.

IN DEPTH

Lab-to-Market Transition: The Evolution of Perovskite Solar Cells

Perovskite solar cells have made remarkable progress in power conversion efficiency over the past decade, demonstrating performance comparable to silicon photovoltaics. However, achieving true commercialization requires overcoming the challenges of scaling up laboratory-scale successes into large-scale module products. This review, published in 'Nature Reviews Clean Technology,' delves into the technical, manufacturing, and industrial aspects necessary for perovskite technology to transition from a "promise" to a "product."

Achieving Both High Efficiency and Stability

For commercial success, the following technical aspects are critical:

- **Formation of Uniform Functional Films:** As devices scale up in area, technologies for depositing uniform and defect-free functional layers—such as the perovskite active layer, electron transport layer, and hole transport layer—become essential. Scalable processes like slot-die coating and blade coating are being developed, but precise control of film thickness, management of grain boundaries, and minimization of surface roughness remain ongoing challenges.
- **Interface Optimization:** Efficient charge transport and suppression of recombination losses at the interfaces between different layers are crucial for maximizing device efficiency. Interface passivation materials and novel interface designs are progressively addressing these issues.
- **Ensuring Long-Term Stability:** Perovskite materials are vulnerable to degradation caused by moisture, oxygen, heat, light, and ion migration. To counteract this, the industry is actively pursuing the development of more robust material compositions, advanced encapsulation techniques, and optimized device structures (e.g., inverted architectures). Encapsulation, in particular, is a decisive factor for achieving extended lifetimes in outdoor environments.

Manufacturing Innovation and the Role of Industry

To enable large-scale production, a transition from laboratory methods to industrially applicable processes is necessary:

- **Scribing Technology:** For large-area modules, laser processing (scribing) is indispensable for precisely separating individual cells and connecting them in series. The development of high-precision and high-speed laser patterning technologies contributes to improved yield and cost reduction.
- **Standardization of Encapsulation Technology:** For commercial perovskite modules to offer long-term warranties, encapsulation processes and materials complying with international standards are required. This includes selecting materials with excellent moisture resistance, UV resistance, and mechanical strength, along with developing mass-production-suitable encapsulation equipment.
- **Synergy Between Science and Industry:** A close collaboration between research institutions, which drive fundamental material science and device physics, and industry, which applies these to manufacturing processes and product development, is essential. This collaboration accelerates innovation and shortens time-to-market.

Impact and Outlook

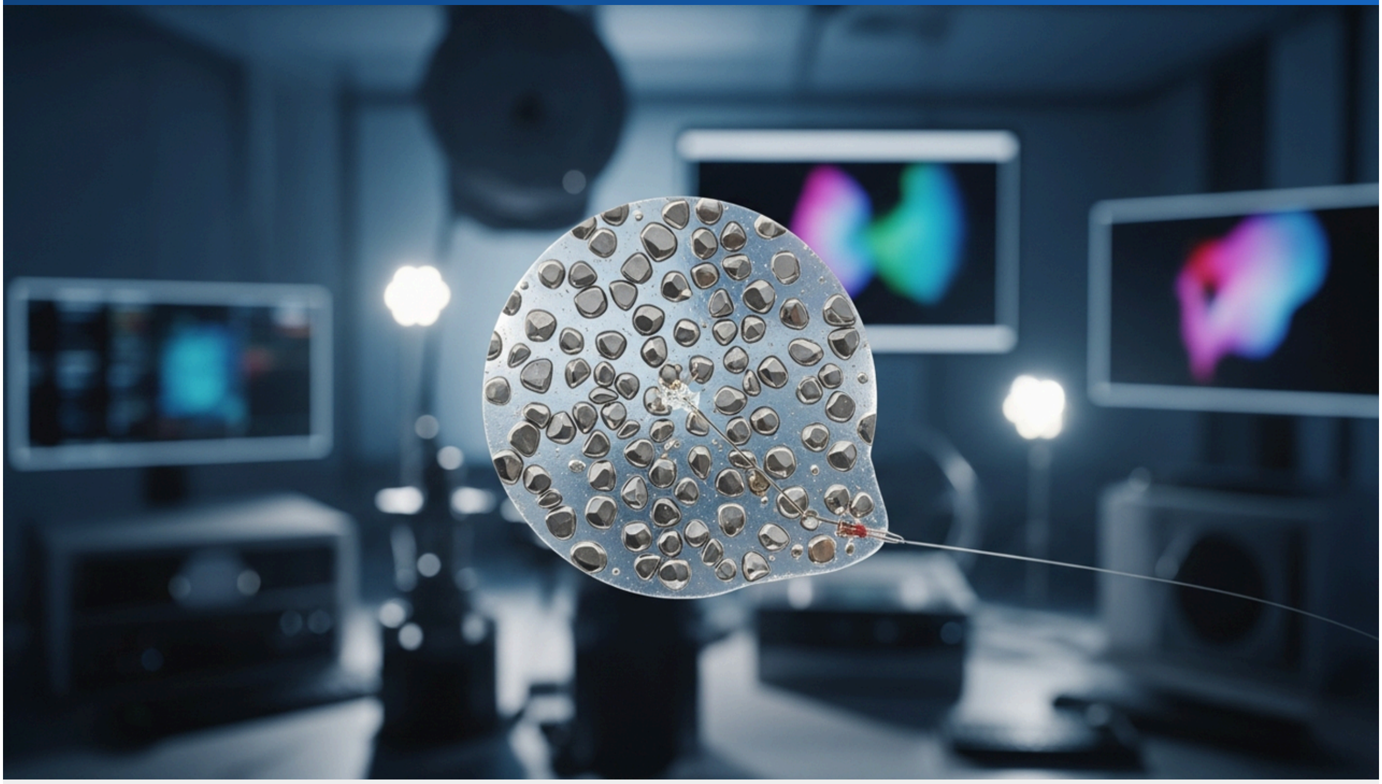
This review demonstrates that perovskite solar cells are steadily overcoming various technical and manufacturing challenges to deliver their "promised" high efficiency to consumers as a "product." Specifically, the industry's proactive investment in R&D focused on stability and scalability reflects strong confidence in the technology's future. Going forward, further enhancing cost competitiveness, addressing environmental regulations, and establishing global supply chains will be the next steps for perovskite solar cells to become a mainstream energy source in the market.

Source:
https://www.researchgate.net/publication/380727041_Taking_perovskite_photovoltaics_from_promise_to_produ

Collected: May 30, 2026 | Automated Research System (Gemini API)

Self-Powered Perovskite Photodetector with 'Chocolate-Chip-Cookie' Architecture for Enhanced Spectral Sensing

Published May 26, 2026 Light: Advanced Manufacturing China



OVERVIEW

This research developed a self-powered photodetector with a unique 'chocolate-chip-cookie' architecture, combining two perovskite materials with different bandgaps. This design optimizes light absorption across specific spectral regions, increasing photocurrent generation. It demonstrates enhanced selective photodetection and smooth carrier flow through a graded energy band structure, promising advancements for next-generation high-performance photodetectors and imaging technologies.

IN DEPTH

Evolution of Photodetector Technology and Perovskite Applications

Photodetectors, devices that convert light signals into electrical signals, are essential across a wide range of fields including communications, medicine, security, and imaging. While traditional photodetectors have utilized materials like silicon, the excellent light absorption properties and charge transport capabilities of perovskite materials have recently garnered significant attention, accelerating the research and development of high-performance perovskite photodetectors. Specifically, "self-powered" photodetectors, which do not require an external power source, offer substantial advantages in applications demanding low power consumption, such as IoT devices and wearable sensors.

Innovation in 'Chocolate-Chip-Cookie' Architecture

Recent research has led to the development of a self-powered perovskite photodetector with an ingenious 'chocolate-chip-cookie' architecture to maximize the potential of perovskite materials. This structure is realized by cleverly combining two different perovskite materials with distinct bandgaps. Specifically, a perovskite material with a lower bandgap is broadly distributed like a "cookie dough," while a perovskite material with a higher bandgap is interspersed like "chocolate chips." This unique design offers the following technical advantages:

- **Optimized Broad-Spectrum Light Absorption:** The combination of materials with different bandgaps enables optimized light absorption across a broad solar spectrum (or specific wavelength ranges) that would be challenging with a single material. The lower bandgap material efficiently absorbs longer wavelength light, while the higher bandgap material absorbs shorter wavelength light.
- **Graded Energy Band Structure:** The dispersion of "chocolate chips" creates a subtle gradient in the energy band structure within the perovskite layer. This facilitates the selective and efficient movement of photogenerated electrons and holes in specific directions, preventing recombination.
- **Smoother Carrier Flow:** This architecture reduces carrier traps and optimizes the charge carrier migration pathways, promoting smoother carrier flow. This results in an increase in photocurrent and an improvement in response speed.

Applications and Future Outlook

This self-powered perovskite photodetector with a 'chocolate-chip-cookie' architecture, published in 'Light: Advanced Manufacturing,' is expected to find diverse applications due to its high-performance characteristics:

- **High-Sensitivity Imaging:** Its selective response to different wavelengths makes it suitable for multispectral imaging and high-resolution image sensors.
- **Environmental Monitoring:** Being low-power and highly sensitive, it can be utilized as a sensor to detect faint light signals or luminescence from chemical substances in the environment.
- **Wearable and IoT Devices:** The combination of self-powering capability and flexibility facilitates integration into devices with battery life constraints.

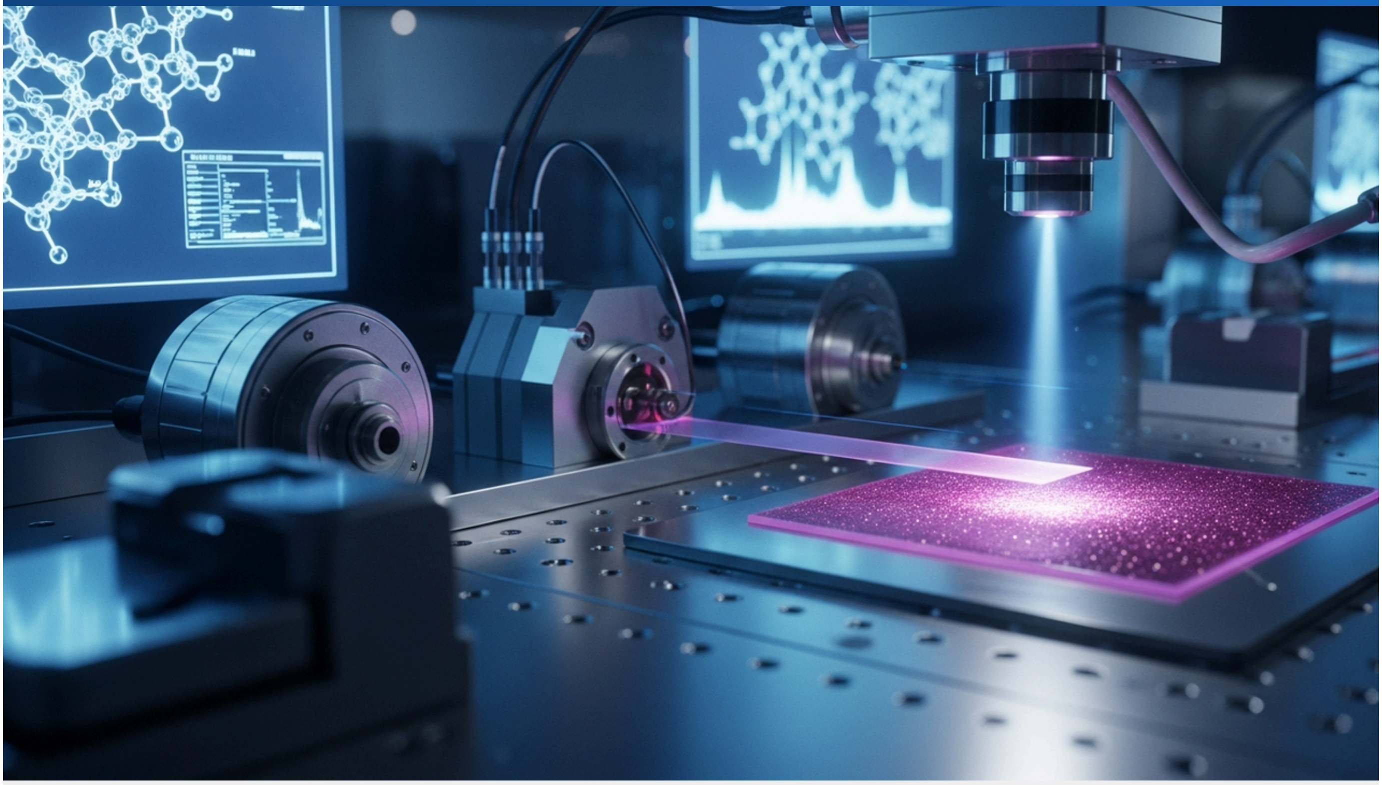
This innovative design opens new possibilities for perovskite materials and contributes to the next generation of photodetector technology. Future research will likely focus on large-area scaling, further verification of long-term stability, and performance optimization tailored for specific application fields.

Source: https://www.light-am.com/article/10.37188/lam.2026.073

Collected: May 30, 2026 | Automated Research System (Gemini API)

Viscoelastic Grain-Boundary Regulation in Blade-Coated Tin–Lead Perovskites Enables High-Efficiency Tandem Solar Cells

Published May 25, 2026 ACS Publications USA



OVERVIEW

This research developed a mechanically adaptive viscoelastic grain-boundary regulation strategy for blade-coated tin–lead (Sn-Pb) perovskite solar cells. By precisely controlling grain-boundary formation during rapid crystallization, the strategy improves structural coherence, reduces residual stress, and suppresses defect density within the perovskite film. This approach achieved 21.02% PCE for 1.25 eV mixed Sn-Pb single-junction cells and 26.94% for monolithic 2-terminal all-perovskite tandem devices, demonstrating a scalable manufacturing pathway for high-performance tandem solar cells.

IN DEPTH

Potential and Challenges of Sn-Pb Perovskites

Perovskite solar cells are emerging as a next-generation technology with the potential to surpass silicon. Specifically, mixed tin–lead (Sn-Pb) perovskites, with their narrow bandgap (approx. 1.2–1.3 eV), hold significant promise for substantially increasing the theoretical efficiency limit when combined in tandem architectures with wide-bandgap perovskites. However, Sn-Pb perovskites have faced challenges in terms of low oxidative stability of tin and difficulties in controlling crystal quality during large-area film deposition, affecting both efficiency and stability. Particularly with scalable blade-coating methods, rapid solvent drying and crystallization tend to induce non-uniform grain boundaries and residual stress.

Novel Strategy with Viscoelastic Grain-Boundary Regulation

This study overcame these challenges by introducing a mechanically adaptive viscoelastic grain-boundary regulation strategy during the formation of Sn-Pb perovskite films using the blade-coating method. This strategy involves incorporating specific additives into the perovskite precursor solution to precisely control grain-boundary formation during the crystallization process. This led to the following significant technical improvements:

- **Enhanced Structural Coherence:** The viscoelastic additives alleviate stress during crystallization and suppress defect formation at grain boundaries, significantly improving the overall structural uniformity and coherence of the perovskite film.
- **Reduced Residual Stress:** Effectively reduces the residual stress within the film, which is commonly induced by rapid drying and crystallization. This enhances the mechanical stability and long-term reliability of the devices.
- **Suppressed Defect Density:** Improved grain boundary quality reduces the density of defects that act as carrier recombination sites, thereby increasing charge transport efficiency.

Achieved High Performance and Tandem Applications

As a result of applying this viscoelastic grain-boundary regulation strategy, the following excellent performances were achieved:

- **1.25 eV Single-Junction Sn-Pb Perovskite Solar Cells:** A high power conversion efficiency of 21.02% was recorded for standalone Sn-Pb perovskite cells. This is one of the highest efficiencies worldwide for narrow-bandgap perovskites.
- **Monolithic 2-Terminal All-Perovskite Tandem Devices:** A monolithic 2-terminal tandem structure was constructed using this Sn-Pb perovskite as the bottom cell and a wide-bandgap perovskite as the top cell. This configuration achieved a high power conversion efficiency of 26.94%. This indicates that all-perovskite tandem solar cells, alongside silicon-based tandem cells, are competitive as next-generation ultra-high-efficiency solar cells.

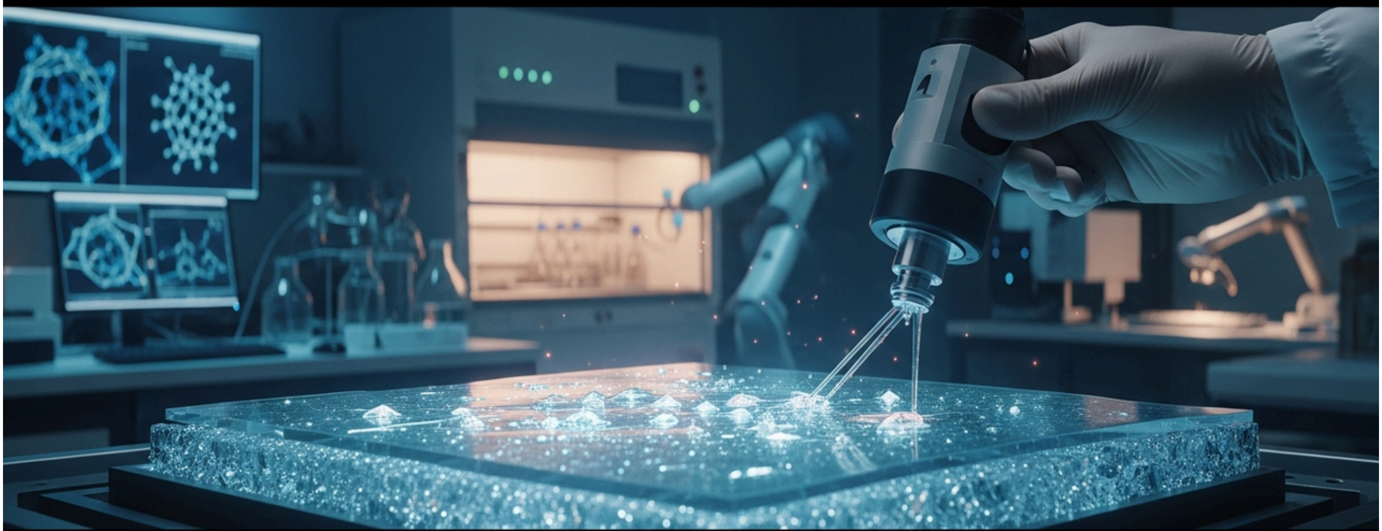
Technical Significance and Future Outlook

This research establishes a groundbreaking method to simultaneously improve the efficiency and stability of Sn-Pb perovskites using a scalable blade-coating technique. This opens a practical manufacturing pathway for large-scale production of tandem solar cells. Notably, the novel concept of viscoelastic control can also be applied to control crystallization in other complex thin-film materials, potentially impacting the broader optoelectronic device sector. Future research will focus on further stability verification and optimization for application in actual manufacturing lines.

Source: https://pubs.acs.org/doi/10.1021/acsenergylett.6c00526

Additive Engineering Mitigates Residual Stress and Boosts Stability in Wide-Bandgap Perovskite Solar Cells

Published May 26, 2026 Materials Futures (IOP Publishing) UK



OVERVIEW

This research details an additive engineering approach incorporating N,N-dimethyl-2-aminosulfonylnicotinamide (ANdPy) into perovskite films to mitigate residual stress and enhance carrier dynamics. ANdPy-modified inverted wide-bandgap perovskite solar cells achieved a champion power conversion efficiency of 18.52% alongside improved photo- and thermal stability. This work offers a reliable strategy to facilitate the commercialization of high-efficiency and high-reliability perovskite solar cells.

IN DEPTH

Enhancing Performance and Addressing Stability in Wide-Bandgap Perovskite Solar Cells

Wide-bandgap perovskite solar cells are crucial components that demonstrate high synergistic effects in tandem structures with silicon-based solar cells, significantly boosting overall power conversion efficiency. However, a common challenge in their fabrication is the formation of residual stress within the perovskite film, which compromises the long-term stability and efficiency of the device. This residual stress is known to accelerate the formation of defects and decomposition, particularly under external stresses such as heat and light, leading to performance degradation.

Stress Mitigation and Carrier Dynamics Enhancement via ANdPy Additive

Recent research proposes an "additive engineering" approach involving the introduction of an organic additive, N,N-dimethyl-2-aminosulfonylnicotinamide (ANdPy), into the perovskite precursor solution. This ANdPy additive performs several critical functions during the formation of the perovskite film:

- **Effective Residual Stress Reduction:** ANdPy contributes to the alleviation of stress during perovskite crystal growth, significantly reducing the residual stress accumulated within the film. This improves the mechanical integrity of the film and enhances its resilience against external stresses.
- **Enhanced Carrier Dynamics:** ANdPy passivates defects at perovskite grain boundaries, suppressing charge carrier recombination. This leads to a more efficient collection of photogenerated electrons and holes, thereby improving carrier transport efficiency.
- **Improved Crystal Quality:** The additive also contributes to optimizing the size and orientation of perovskite crystal grains, facilitating the formation of a more uniform and highly crystalline film.

Achieved High Performance and Reliability

ANdPy-modified inverted wide-bandgap perovskite solar cells demonstrated excellent performance:

- **Champion Efficiency:** A high power conversion efficiency of 18.52% was achieved. This represents excellent performance for wide-bandgap perovskites, especially considering their high potential when used as top cells in tandem structures.
- **Improved Photostability:** In continuous operation tests under illumination, ANdPy-added devices showed significantly higher stability compared to unmodified devices. The reduction in residual stress and defect passivation is believed to suppress photo-induced degradation.
- **Enhanced Thermal Stability:** ANdPy-added devices maintained excellent stability even in high-temperature environments, which is crucial for improving durability in practical outdoor conditions.

Technical Significance and Future Outlook

This additive engineering approach, published in 'Materials Futures,' offers a reliable strategy for the commercialization of wide-bandgap perovskite solar cells. By simultaneously managing residual stress and defects, it opens a path to achieving both high efficiency and high stability. Future research will likely focus on the mass production of ANdPy, its applicability to other perovskite compositions, and scaling up to large-area devices. This technology is expected to play a significant role in accelerating the widespread adoption of perovskite solar cells as a next-generation renewable energy technology.

Source: https://iopscience.iop.org/article/10.1088/2752-5724/ae726c

Collected: May 30, 2026 | Automated Research System (Gemini API)