MULTIJUNCTION SOLAR CELLS

Patent & Technology Landscape Report

IIPRD

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Executive Summary

The evolution of solar cell efficiency, from a modest 20% to nearly double that figure, is not merely a tale of scientific advancement; it is a testament to overcoming once insurmountable challenges. This progress paves the way for a future dominated by high-efficiency solar solutions. The global solar cell market, valued at $84.91 billion in 2021, is projected to reach $367.23 billion by 2031, growing at a compound annual growth rate (CAGR) of 15.8% from 2022 to 2031 and Multijunction solar cells seems to be a major accelerator in the growth of solar cell technology.

Multijunction solar cells (MJSC) began their journey with the two-junction (2j) AlGaAs/GaAs solar cell, where a tunneling diode connected two subcells in series. Today, MJSC integrate three distinct materials—GaInP, InGaAs, and Ge—differentiating them from traditional silicon-based single-junction cells and significantly enhancing their performance.

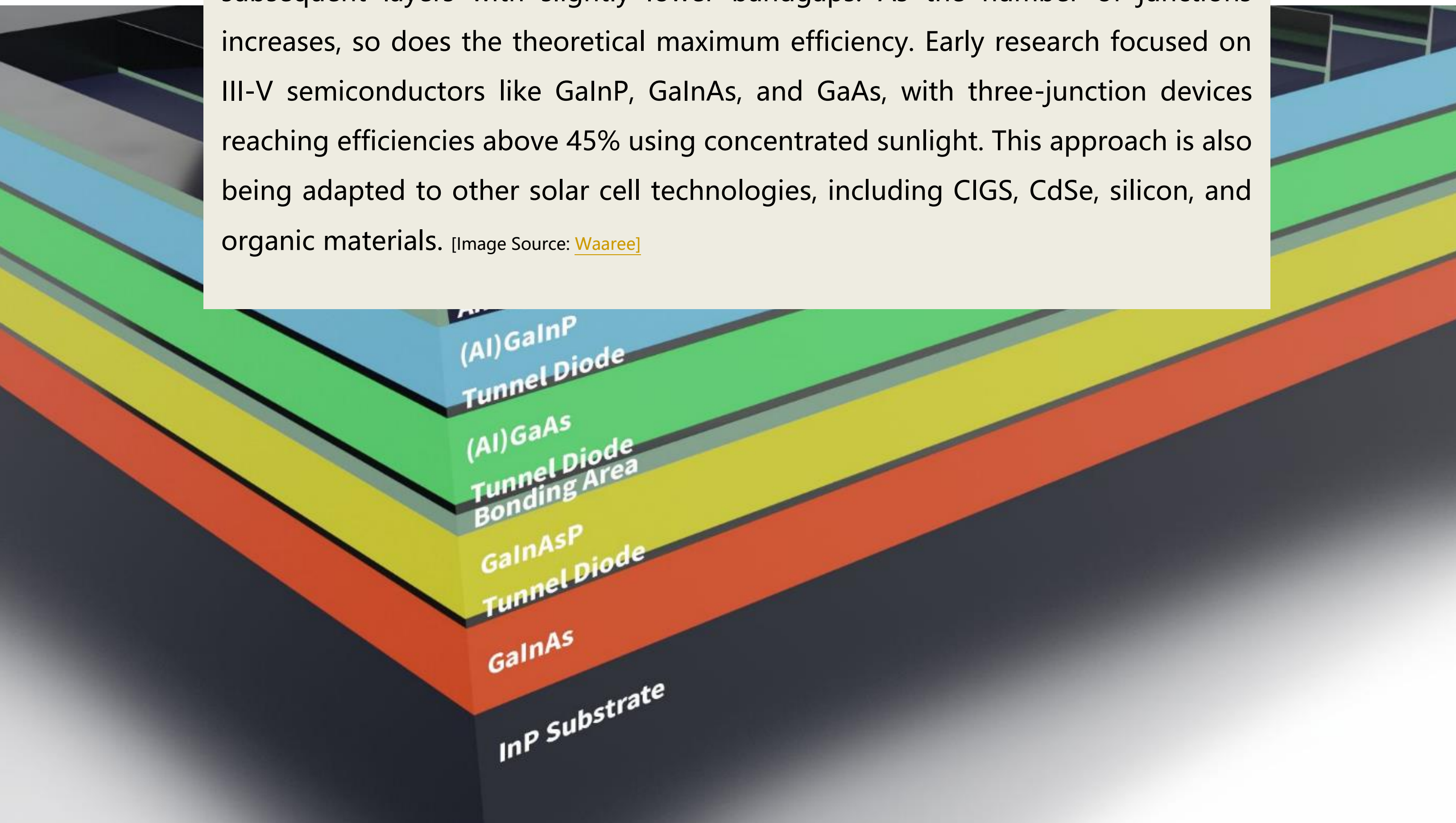
While single-junction silicon-based solar cells have achieved a maximum efficiency of 26.7%, MJSC have reached 47.1% efficiency under 143 suns (6-junction). Although Multijunction III-V cells achieve higher efficiencies than competing technologies, their current fabrication techniques and materials make them considerably more costly. Active research efforts are focused on lowering the cost of electricity generated by these solar cells through various approaches, including the development of new substrate materials, absorber materials, and fabrication techniques; increasing efficiency; and extending the Multijunction concept to other photovoltaic (PV) technologies. Additionally, due to the high cost of these solar cells, there is ongoing research into developing reliable, low-cost solutions for tracking and concentration, which are crucial for reducing the overall costs of PV systems utilizing Multijunction cells. R&D efforts in this field are accelerating, with over 2300 patents addressing these aspects of MJSC, and focusing on further enhancing their effectiveness and efficiency.

Introduction

Multijunction solar cells use multiple layers with different bandgaps to capture various parts of the solar spectrum, significantly enhancing efficiency. By stacking these layers, they achieve higher power output compared to traditional single-junction cells.

High-efficiency Multijunction devices achieve over 45% efficiency by using multiple bandgaps or junctions, each tuned to absorb specific parts of the solar spectrum. The theoretical efficiency limit for a single-bandgap solar cell under non-concentrated sunlight is around 33.5%, known as the Shockley-Queisser limit. This limit exists because a cell's open-circuit voltage (Voc) is restricted by the bandgap of its material, with lower-energy photons not being absorbed and excess energy from higher-energy photons lost as heat.

Multijunction cells overcome this by stacking a high-bandgap top cell that captures high-energy photons, allowing lower-energy photons to pass through to subsequent layers with slightly lower bandgaps. As the number of junctions increases, so does the theoretical maximum efficiency. Early research focused on III-V semiconductors like GaInP, GaInAs, and GaAs, with three-junction devices reaching efficiencies above 45% using concentrated sunlight. This approach is also being adapted to other solar cell technologies, including CIGS, CdSe, silicon, and organic materials. [Image Source: Waaree]



Traditional multijunction III-V cells are built as epitaxial monolithic stacks, where subcells are connected in series via tunnel junctions. This monolithic structure requires that the subcells' layers be lattice-matched, meaning their atomic lattice positions must be compatible. Germanium (Ge) is commonly used as the substrate and narrow bandgap cell because it is lattice-matched with certain III-V alloys. However, overcoming lattice mismatch can be achieved with more complex methods like wafer bonding or using metamorphic buffer layers.

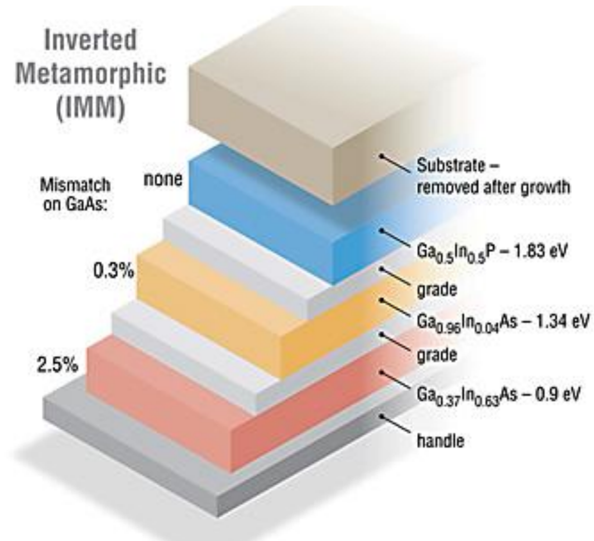


Fig. 1: Three-junction IMM solar cell [source: NREL]

The tunnel-junction layer is formed at the interface of highly doped p++ and n++ layers, creating a narrow space-charge region that facilitates current flow between subcells. To prevent carrier recombination at the interface, high-bandgap layers called window layers and back-surface fields are added to passivate surface states.

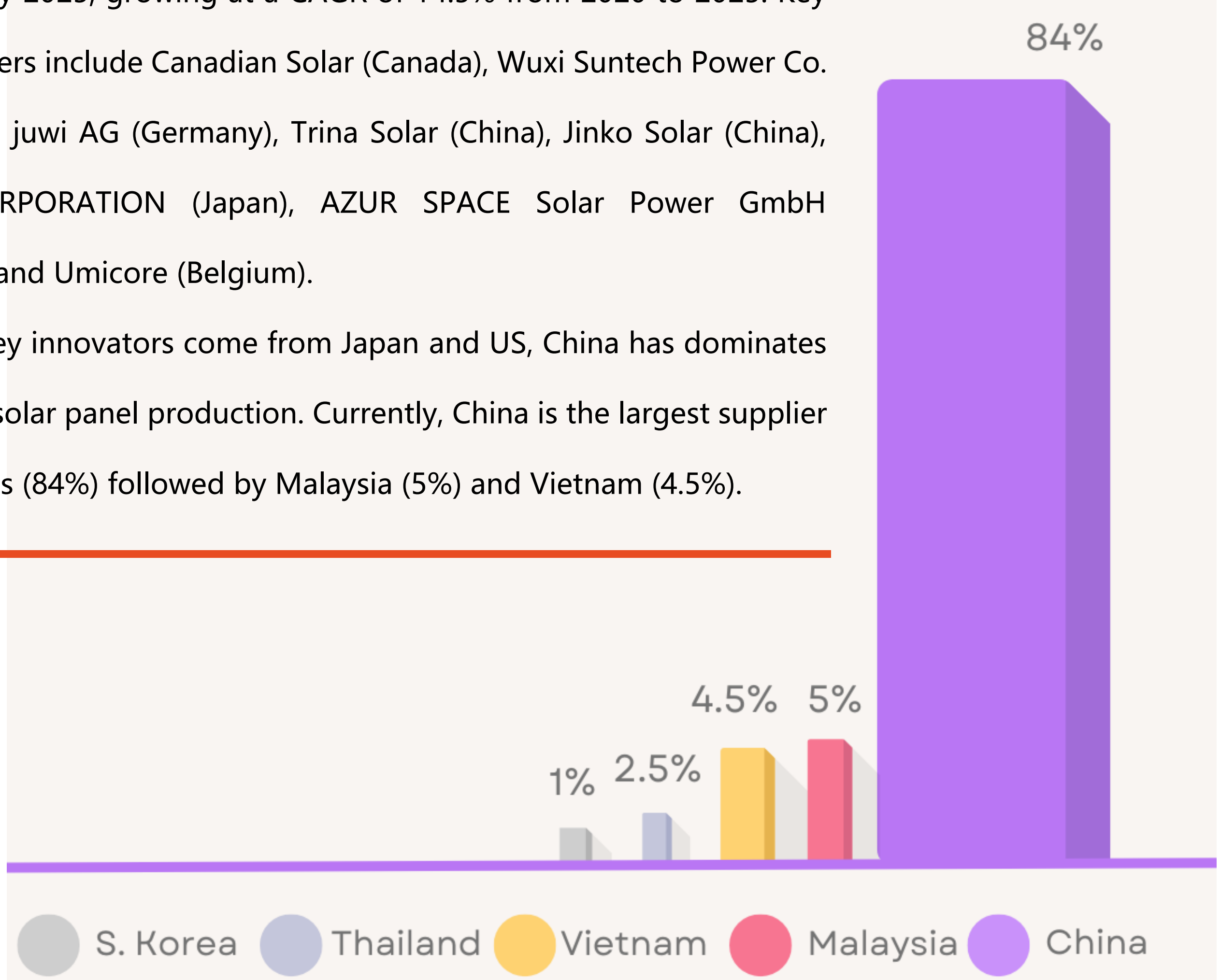
When subcells are connected in series, the overall current is limited by the subcell with the lowest current output, making current matching crucial. Luminescent coupling between subcells can help ease these current-matching requirements.

Multijunction III-V solar cells are typically fabricated using molecular-beam epitaxy (MBE) or large metal-organic chemical-vapor deposition (MOCVD) reactors for commercial-scale production of GaInP/GaInAs/Ge devices. These processes involve growing layers from materials like trimethylgallium, trimethylindium, arsine, and phosphine in a hydrogen carrier gas, with dopants such as hydrogen selenide, silane, and diethyl zinc. By using concentrating optics, individual cells can be made very small, sometimes as small as a pencil tip, allowing hundreds of cells to be grown in a single batch. Ongoing research aims to further reduce cell size and increase the number of cells per wafer, which will lower the cost per cell. [Source: LINK]

Current Market Landscape

The global multi-junction solar cell market is experiencing significant growth, with estimates from ABI Analytics placing its value at USD 2.04 billion in 2022, expected to grow at a CAGR of 11.95% from 2023 to 2030. Data Bridge Market Research reports that multi-junction solar cells were valued at USD 1.74 billion in 2021 and are projected to reach USD 5.05 billion by 2029, registering a CAGR of 11.70% during the forecast period. IndustryARC forecasts the multi-junction solar cell market to reach USD 3.5 billion by 2025, growing at a CAGR of 14.5% from 2020 to 2025. Key market players include Canadian Solar (Canada), Wuxi Suntech Power Co. Ltd. (China), juwi AG (Germany), Trina Solar (China), Jinko Solar (China), SHARP CORPORATION (Japan), AZUR SPACE Solar Power GmbH (Germany), and Umicore (Belgium).

Although Key innovators come from Japan and US, China has dominates all steps of solar panel production. Currently, China is the largest supplier of Solar Cells (84%) followed by Malaysia (5%) and Vietnam (4.5%).



Technology Overview & Current State of Research

Regarding Multijunction solar cells, the triple-junction (3-J) solar cell is currently the most prevalent type. This cell features three semiconductor absorbers separated by tunneling junctions. However, ongoing research aims to incorporate additional junctions to optimize sunlight utilization.

Researchers at the US Department of Energy's National Renewable Energy Laboratory (NREL) have devised a comprehensive roadmap to accelerate the commercialization of tandem solar cells, particularly those that integrate various photovoltaic (PV) technologies. A recent publication in Joule underscored the critical need for expanding solar power globally, projecting that 75 TW of PV capacity will be required by 2050 to meet the demands of a growing population and increased electrification across all energy sectors. [LINK]

On May 18, 2022, an article titled "Triple-junction solar cells with 39.5% terrestrial and 34.2% space efficiency enabled by thick quantum well superlattices," published in Joule, reported that NREL researchers achieved a record efficiency of 39.5% under 1-sun global illumination, the highest efficiency for any solar cell type under standard 1-sun conditions. Prior to this, NREL set a record in 2020 with a 39.2% efficient six-junction solar cell using III-V materials.

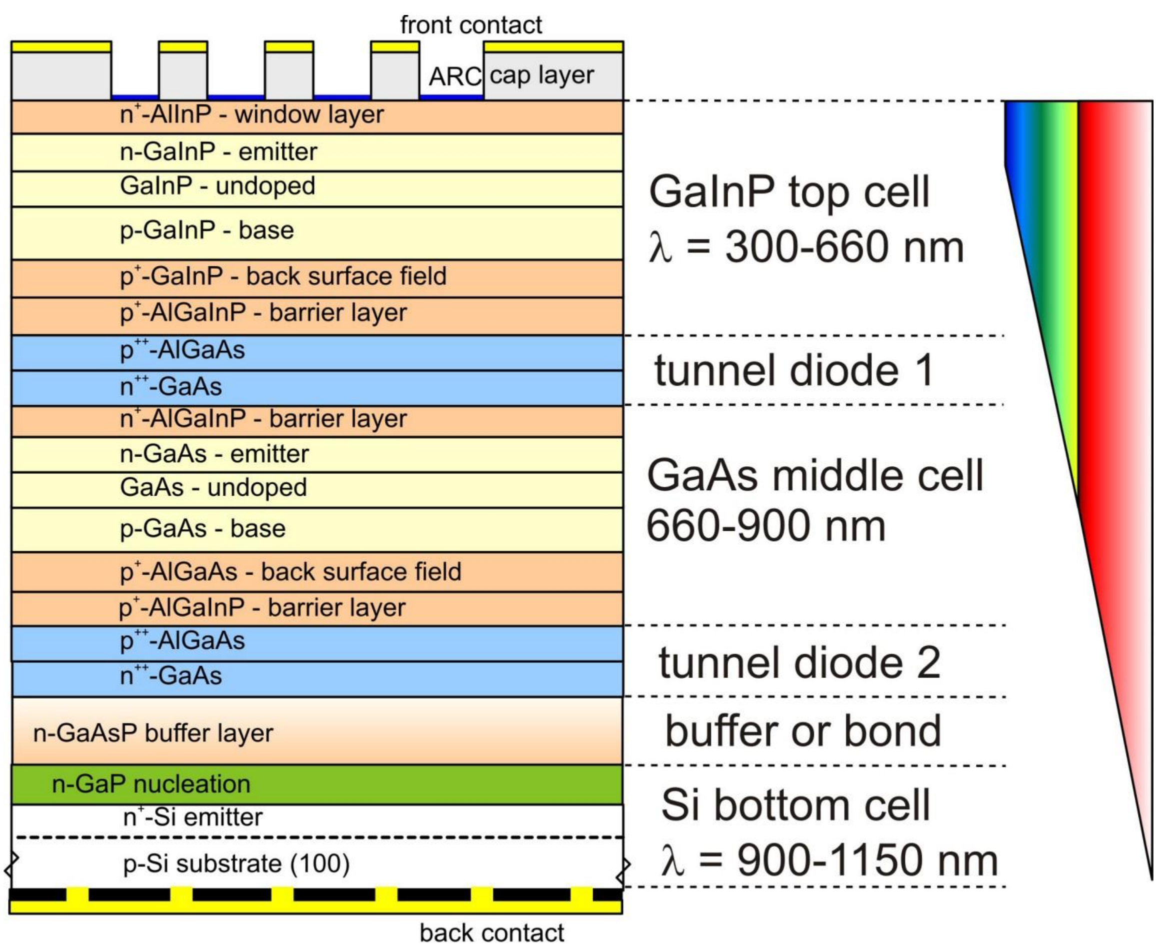
Recent advancements have also highlighted the inverted metamorphic multijunction (IMM) architecture, which was developed at NREL. The newly enhanced triple-junction IMM solar cell has been added to the Best Research-Cell Efficiency Chart, surpassing the previous record of 37.9% established in 2013 by Sharp Corporation.

Adding fuel to efforts by US Department of Energy's National Renewable Energy Laboratory (NREL), in August, 2024, researchers at the University of Oxford's Physics Department claimed a thin-film perovskite material utilizing the multi-junction method, achieving an independent certification of over 27% efficiency.

Before this, in March 6, 2024, a research team from the National University of Singapore (NUS) developed an innovative triple-junction perovskite/silicon tandem solar cell, attaining a certified world-record power conversion efficiency of 27.1% over a 1 cm^2 solar energy absorption area.

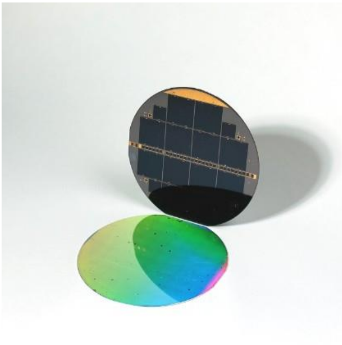
On January 8, 2024, a research group from the Center for Physical Sciences and Technology (FTMC, Lithuania), in collaboration with Tallinn University of Technology (Estonia), synthesized a novel material—tin zirconium titanium selenide (Sn(ZrxTi1-x)Se3)—which has the potential to complement silicon solar cell technologies and enhance overall photovoltaic module efficiency. Their findings, published in the Journal of Materials Chemistry A, focus on semiconductors with a perovskite-like chemical structure, using non-toxic metals in place of oxygen or halogens.

Among various research groups and corporates, researchers from the Fraunhofer Institute seems the flag bearer. Earlier in 2023, Fraunhofer for Solar Energy Research ISE and NWO-Institute AMOLF (Amsterdam) achieved a new milestone with a multijunction solar cell that boasts an efficiency of 36.1%, the highest recorded for a silicon-based solar cell. This record was presented at the European Photovoltaic Solar Energy Conference (EU PVSEC) in Lisbon on September 21, 2023, with funding provided through the Fraunhofer ICON program. Frank Dimroth of Fraunhofer ISE commended the collaborative efforts, noting that the combined advancements from AMOLF's new back reflector and the improved GaInAsP middle cell from Fraunhofer contributed to this exceptional result



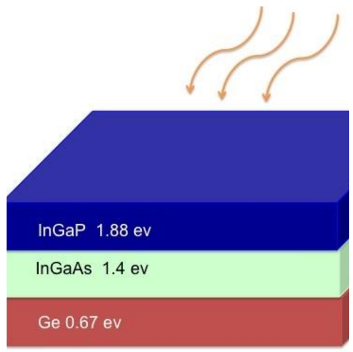
[**Image:** Triple-junction solar cell made of GaInP/GaAs/Si with active Si bottom cell. Source: Fraunhofer ISE]

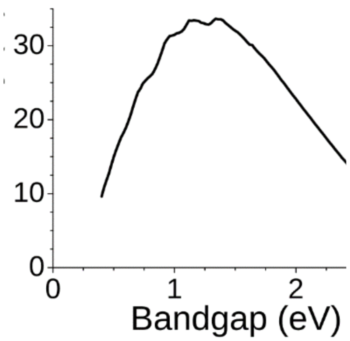
Efficiency & Cost-effectiveness Comparison



The journey of solar cell efficiency began with a modest 20% photoconversion efficiency (PCE) for tandem solar cells. Today, this has advanced to an impressive 47.1% efficiency with six-junction configurations.

Multijunction solar cells, particularly those with three junctions, theoretically achieve efficiencies exceeding 45%. In contrast, single-junction cells are limited to around 33.5% efficiency. The addition of more junctions, potentially up to five or six, could further increase efficiency to over 70%. For context, the most efficient solar panels available today offer around 22% efficiency.





Single-junction solar cells are constrained by the Shockley-Queisser limit, which dictates a maximum theoretical efficiency of about 33.5% under non-concentrated sunlight. This limitation arises from the broad spectrum of solar photons and the inherent inefficiency in capturing photon energy above the material's bandgap, which is lost as heat.

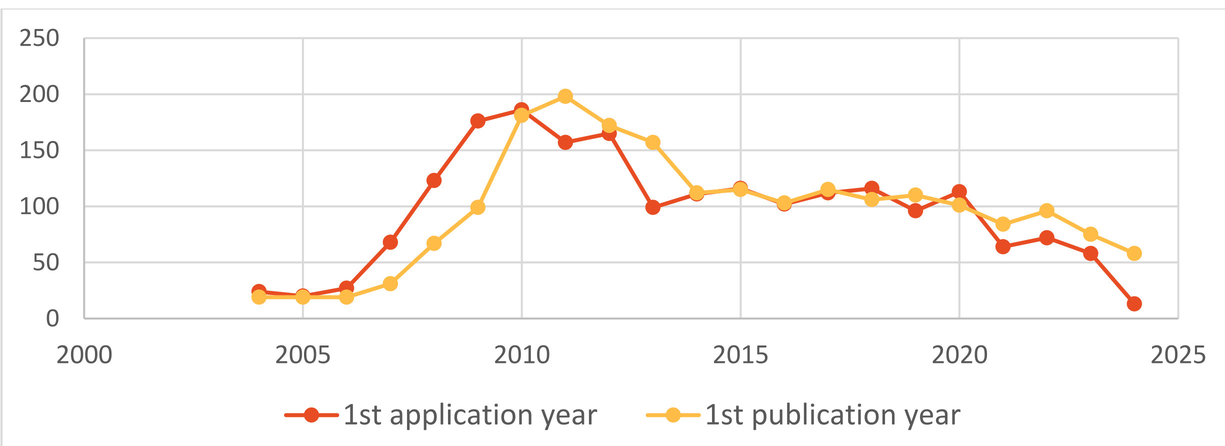
Despite their higher efficiency, multijunction III-V solar cells are significantly more expensive due to complex fabrication processes and the use of costly materials. Currently, there are no commercially available multijunction solar cells, and their pricing remains speculative. As manufacturing technologies advance and become more efficient, it is anticipated that the cost of tandem solar cells will decrease over time, following the trend of declining solar panel prices in recent years.

Patent Landscape Analysis

Research on multijunction solar cells began in the 1980s, when Jerry Olson, a researcher at the Solar Energy Research Institute (SERI), challenged the belief that gallium indium phosphide (GaInP) alloys could not be used as semiconductors. For more than a decade, the research was in pre-experiment phase and only a few patents were filed to protect the concept of Multijunction Solar cell.

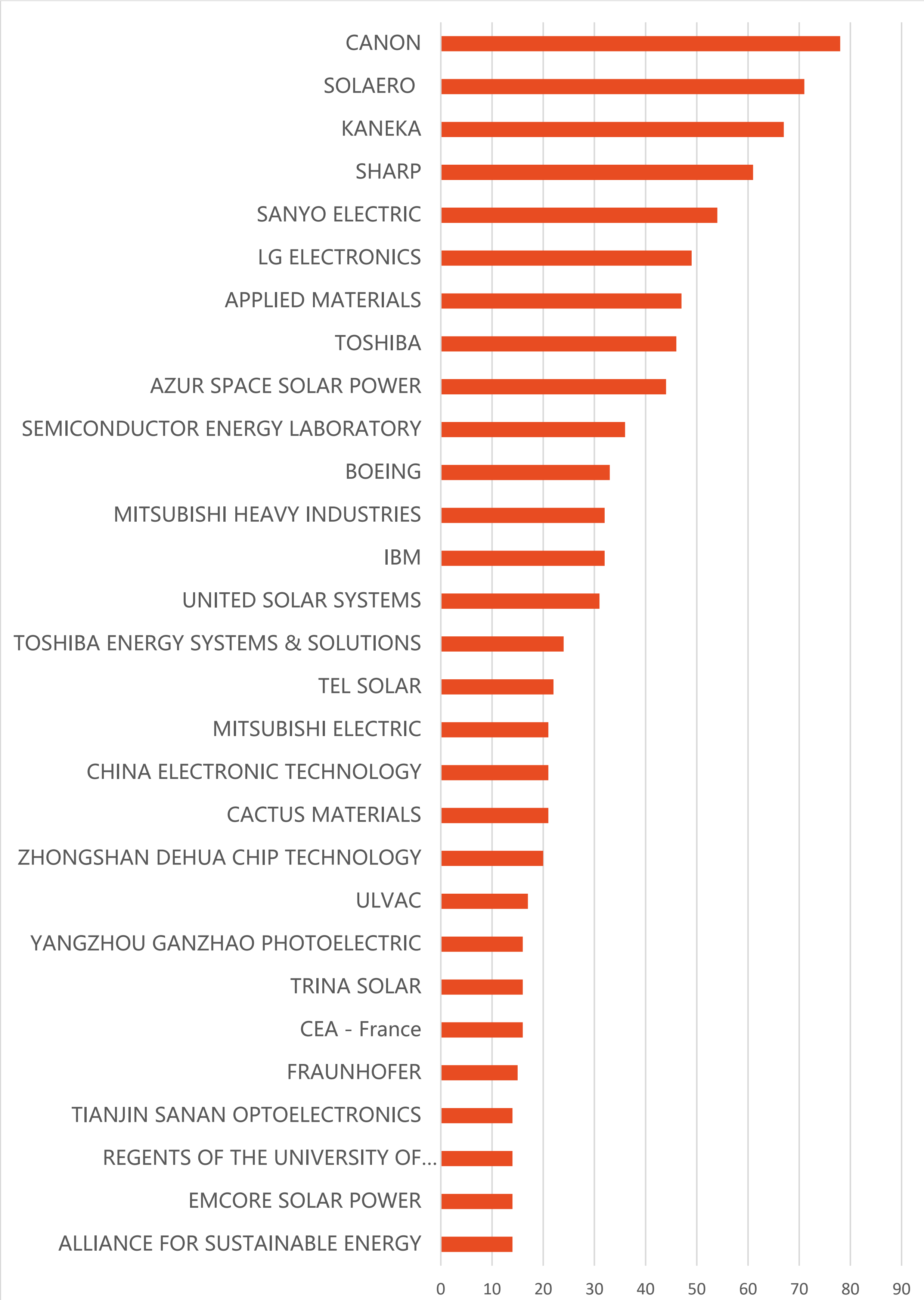
However, during late 2000s and early 2010's, when government across the globe came together to fight climate change and started research to develop more efficient non-renewable energy sources, it gave birth to Paris Agreement, a legally binding international treaty that aims to reduce greenhouse gas emissions and help countries adapt to climate change in 2015 and also opened avenues for increased research to enhance the efficiency of nonrenewable energy resources.

The below graph depicts patent application filing year and patent publication trend since 2004. So far, close to 2500 patents have been filed in Multijunction Solar cell domain.



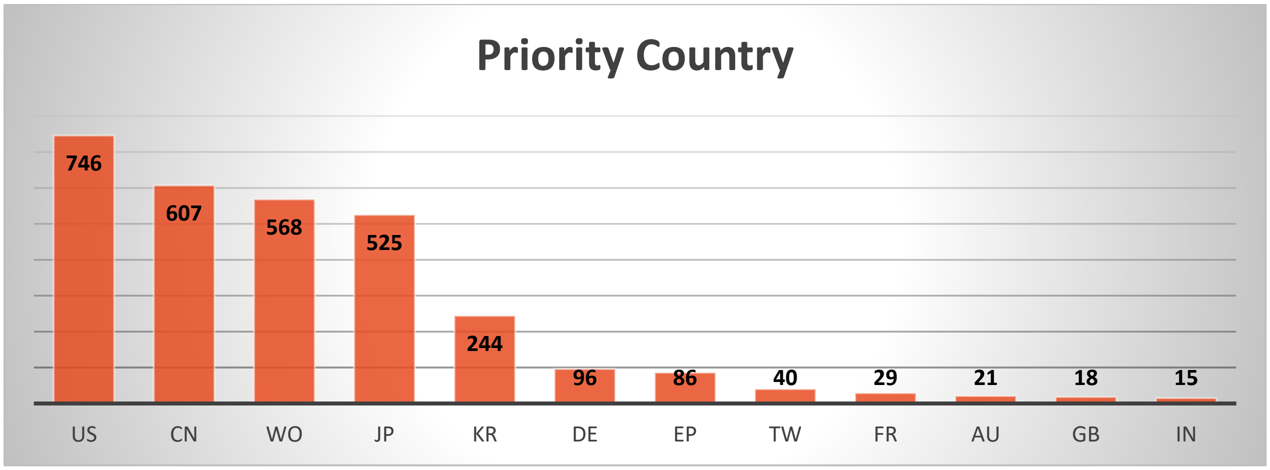
With Canon, KANEKA Solar Energy, Sharp and Sanyo from Japan being the top players in this list, USA's satellite solar power producer SolAero Technologies which was acquired by Rocket Lab in 2022 is leading the technology innovation race in race in Multijunction Solar cell space.

Below graph depicts count of patent families assigned to key players in Multijunction Solar call domain.


CANON
SOLAERO
KANEKA
SHARP
SANYO ELECTRIC
LG ELECTRONICS
APPLIED MATERIALS
TOSHIBA
AZUR SPACE SOLAR POWER
SEMICONDUCTOR ENERGY LABORATORY
BOEING
MITSUBISHI HEAVY INDUSTRIES
IBM
UNITED SOLAR SYSTEMS
TOSHIBA ENERGY SYSTEMS & SOLUTIONS
TEL SOLAR
MITSUBISHI ELECTRIC
CHINA ELECTRONIC TECHNOLOGY
CACTUS MATERIALS
ZHONGSHAN DEHUA CHIP TECHNOLOGY
ULVAC
YANGZHOU GANZHAO PHOTOELECTRIC
TRINA SOLAR
CEA - France
FRAUNHOFER
TIANJIN SANAN OPTOELECTRONICS
REGENTS OF THE UNIVERSITY OF...
EMCORE SOLAR POWER
ALLIANCE FOR SUSTAINABLE ENERGY
0
10
20
30
40
50
60
70
80
90

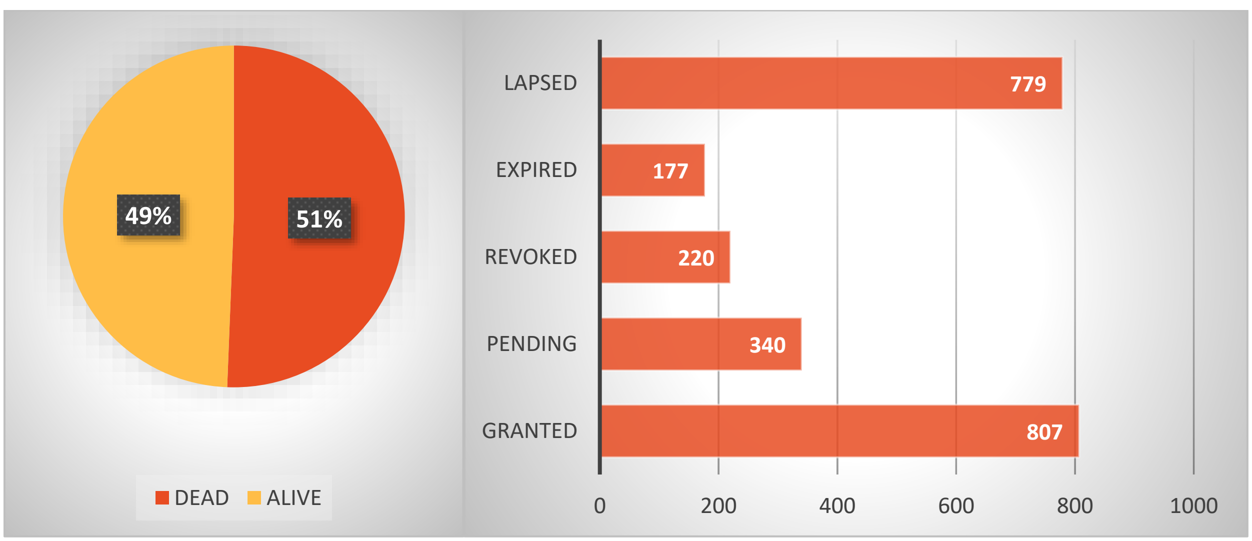
Origin Country

With numerous incentive programs and investments provided by the U.S. government, the United States leads the way in Multijunction solar cell research, closely followed by Japan, where significant contributions are made by research efforts from companies like Kaneka, Canon, Sharp, Sanyo, Toshiba, and others.



Legal Status

Interestingly close to half of the patents in this domain that relate to outdated technologies developed by Canon and others, majorly pertaining to PN Homojunction is now dead and focus has now shifted toward Heterojunction Cells that are more efficient and effectively captures wide range of sunlight.



Technology Distribution

Potential Barrier Type

PN HomoJunction

These patents disclose technologies wherein junction is formed between two regions of the same semiconductor material that have been doped differently.

507

- Metamorphic [IMM] multiple junction solar cells **(110)**
- Only AIIIBV compounds, e.g. GaAs or InP solar cells **(125)**
- Only of the PN homojunction type **(390)**

PN Heterojunction

These Patents disclose technologies wherein junction is formed between two different semiconductor materials with distinct bandgaps and electronic properties.

1043

- AIIBVI compound semiconductors, e.g. CdS/CdTe solar cells (56)
- AIIIBV compound semiconductors, e.g. GaAs/AlGaAs or InP/GaInAs (290)
- Eement of Group IV of the Periodic Table, e.g. ITO/Si, GaAs/Si or CdTe/Si **(84)**
- AIVBIV heterojunction, e.g. Si/Ge, SiGe/Si or Si/SiC (51)
- Crystalline and amorphous materials (76)
- AIBIIICVI compound, e.g. CdS/CuInSe2 [CIS] (78)

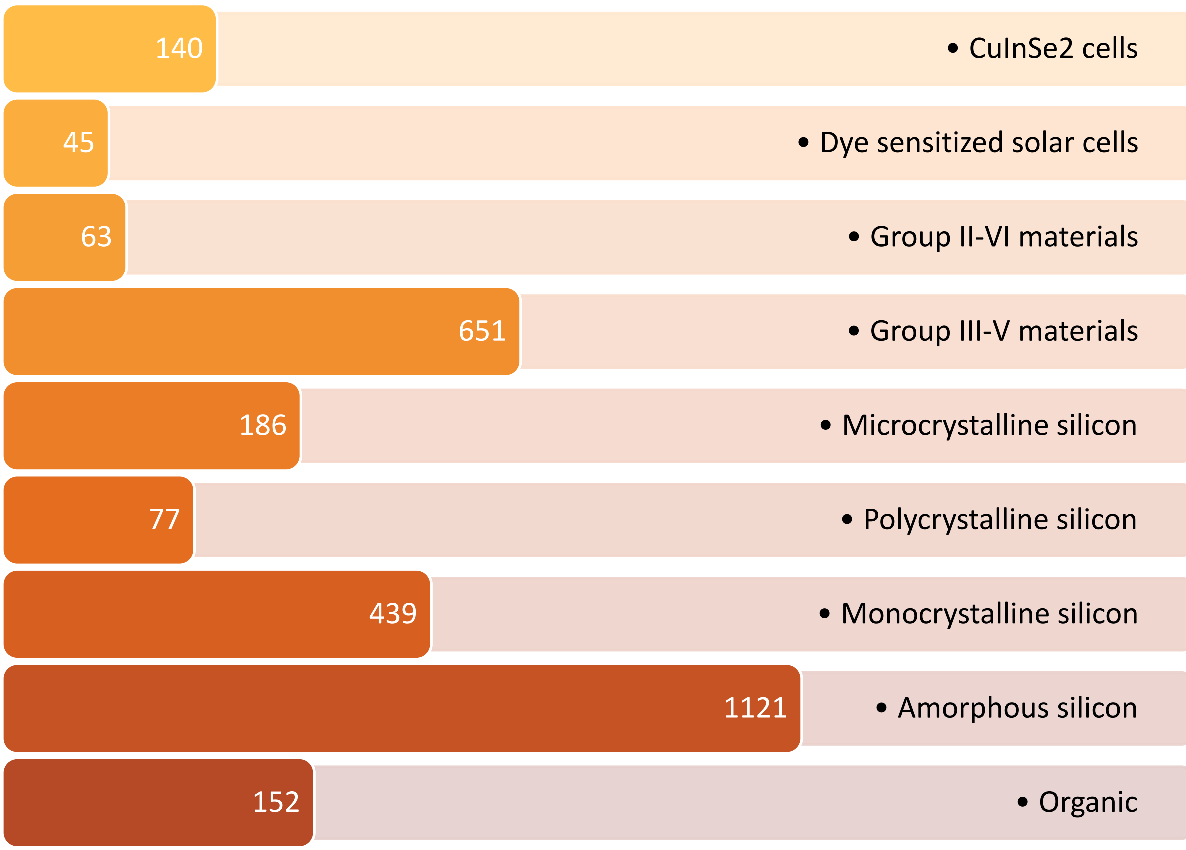
PIN Type

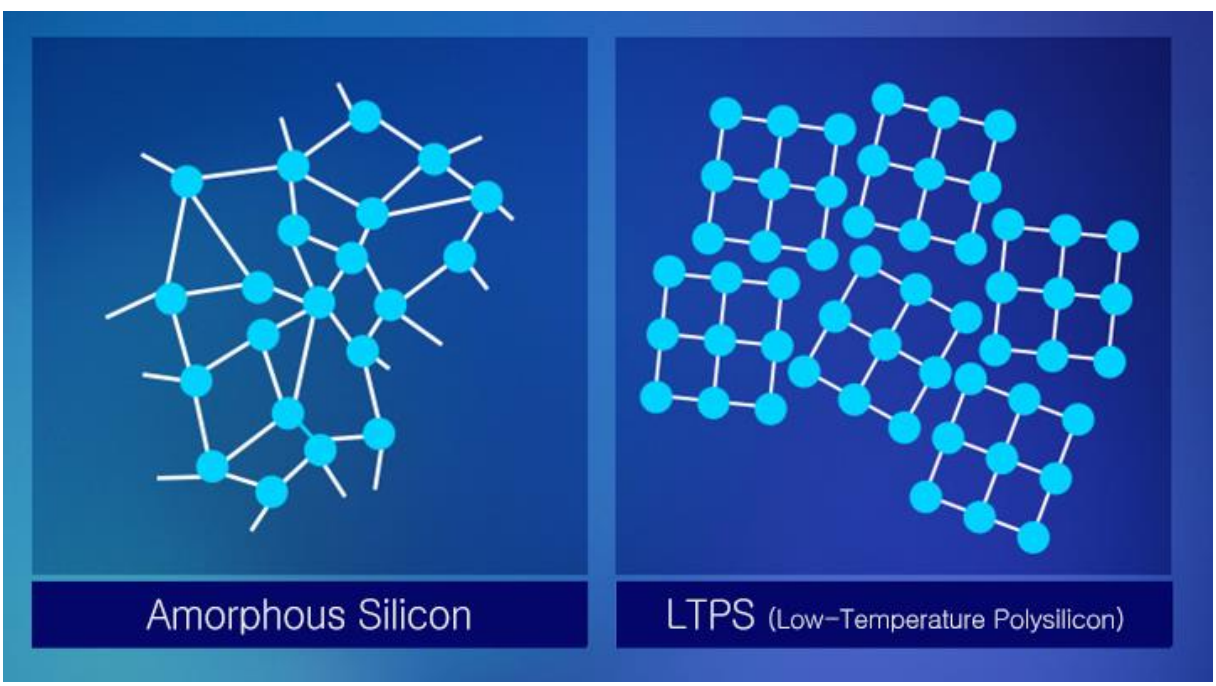
These patents disclose technologies where an undoped or lightly doped intrinsic layer is interposed between PN Layers and acts as a region with low conductivity.

1255

- Amorphous semiconductor materials comprising only elements of Group IV (340)
- Monocrystalline silicon PV cells (103)
- Transparent conductive Electrode layers, e.g. TCO, ITO layers (101)

Semiconductor Material





[Image source: Samsung]

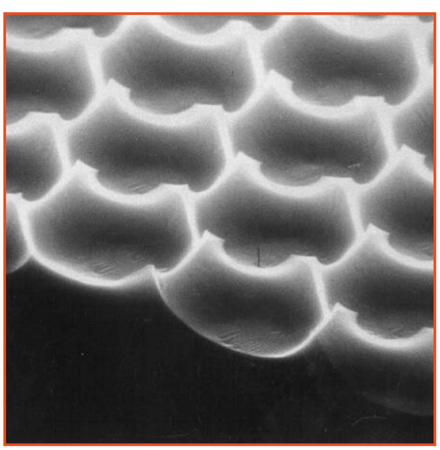
Surface textures

Surface texturing, whether used alone or in conjunction with an anti-reflection coating, reduces reflection. Roughening the surface enhances light trapping by increasing the likelihood that reflected light will be redirected back onto the surface rather than escaping into the surrounding air.

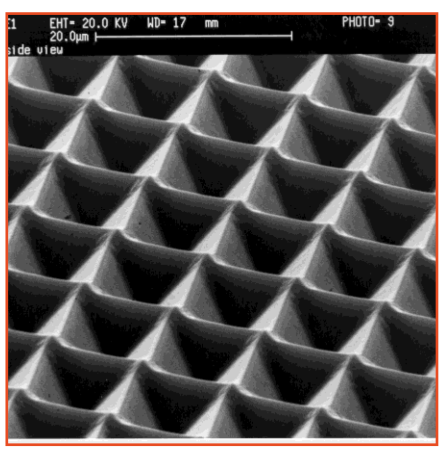
In solar cells it can be achieved through using a textured semiconductor body or adding a textured layer onto the solar cell. Below image shows distribution of patents in this filed. In current industry scenario, both methods seems equally efficient and are widely used in their standard form. [IMAGE SOURCE- LINK]

Special surface textures	
Textured Semiconductor Body	91
Textured substrate or a textured layer on the substrate (Textured substrate or a textured layer on the substrate)	88

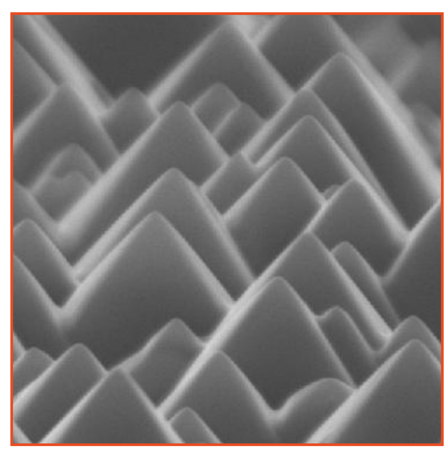
HONEYCOMB



INVERTED PYRAMID

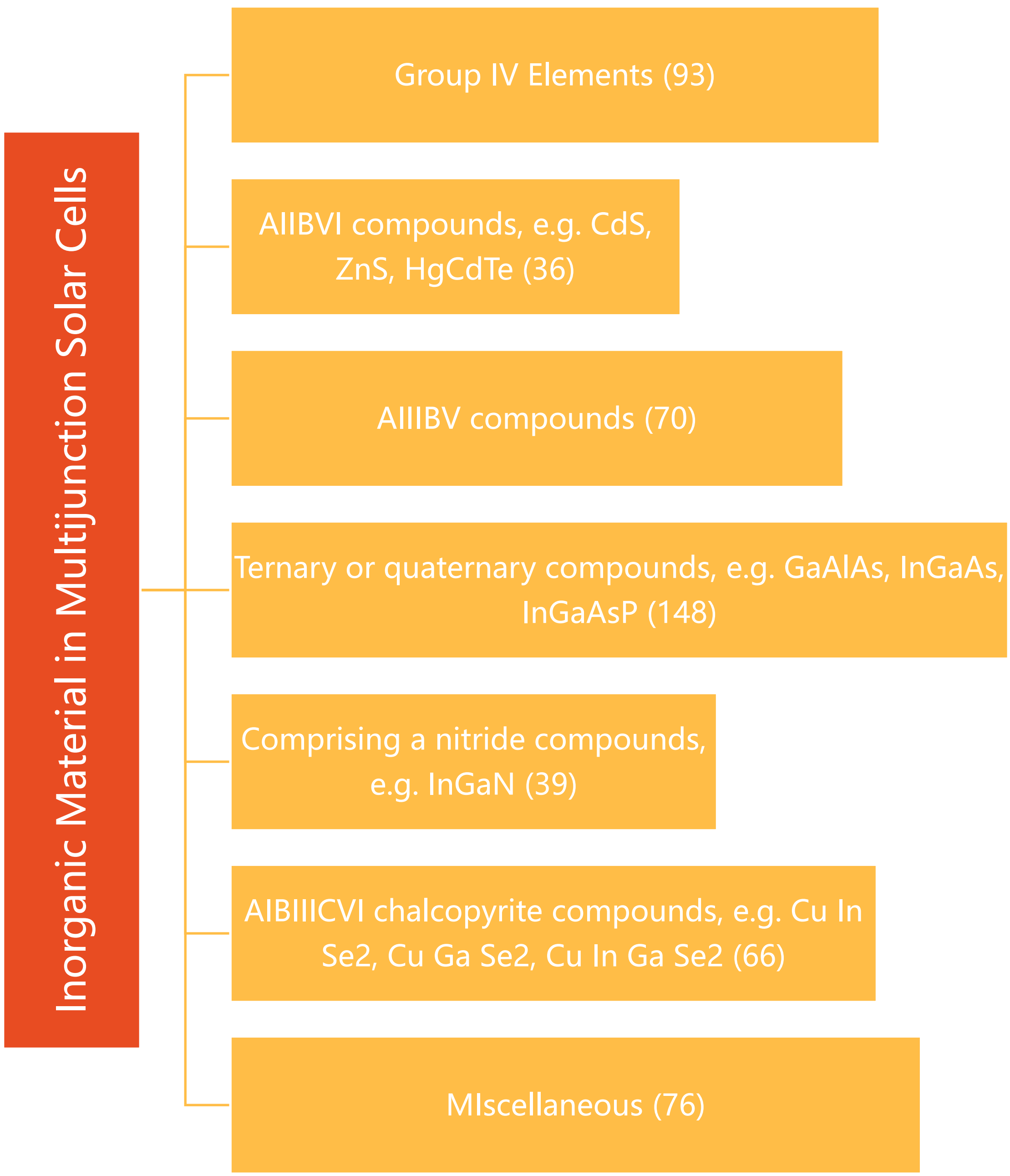


PYRAMID



Inorganic Materials

Inorganic materials are used for their high efficiency and durability. Silicon, gallium arsenide (GaAs), and cadmium telluride (CdTe) are commonly used due to their superior light-to-electricity conversion rates. These materials ensure long-term stability and reliability, making them suitable for various applications, from residential panels to space devices.



Shapes, Relative Sizes, or Arrangements of Semiconductor Regions

Nearly 250 patents pertain to the shapes, relative sizes, or arrangements of semiconductor regions. These patents cover innovations in optimizing the physical structure of semiconductor materials to enhance device performance and functionality.

Thirty-nine patents focus on technologies involving quantum structures, specifically quantum dots. These patents explore various applications and advancements related to the use of quantum dots in enhancing electronic and optoelectronic device performance.

While 53 patents relate to superlattices and multiple quantum well structures within Multijunction Solar cell technology space.

82 Shape of the Semiconductor body

60 Shape of the potential jump barrier or surface barrier

46 Quantum structure (quantum dots)

53 Superlattices and Multiple quantum well structures

Thin film solar cells deposited on the same substrate

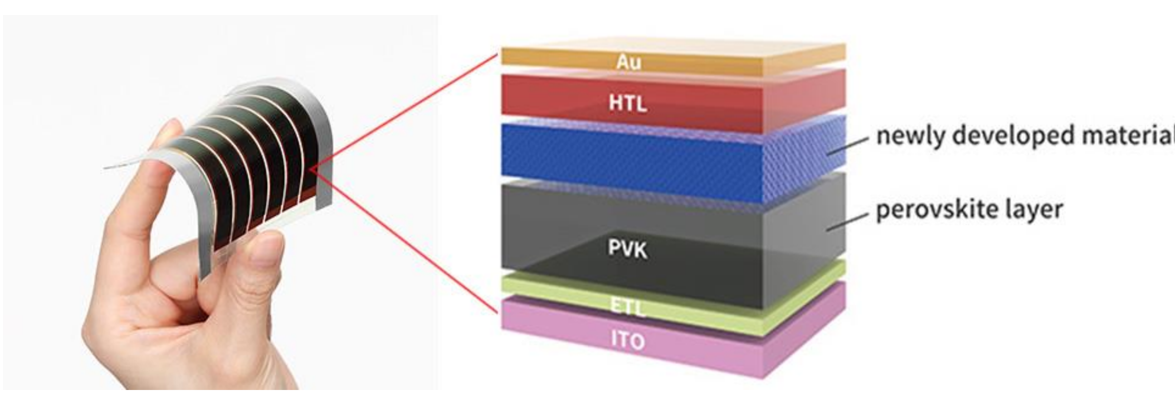
Special patterning methods to connect the PV cells in a module, e.g. laser cutting of the conductive or active layers (55)	Particular structures for the electrical interconnection of adjacent PV cells in the module (72)
55	72

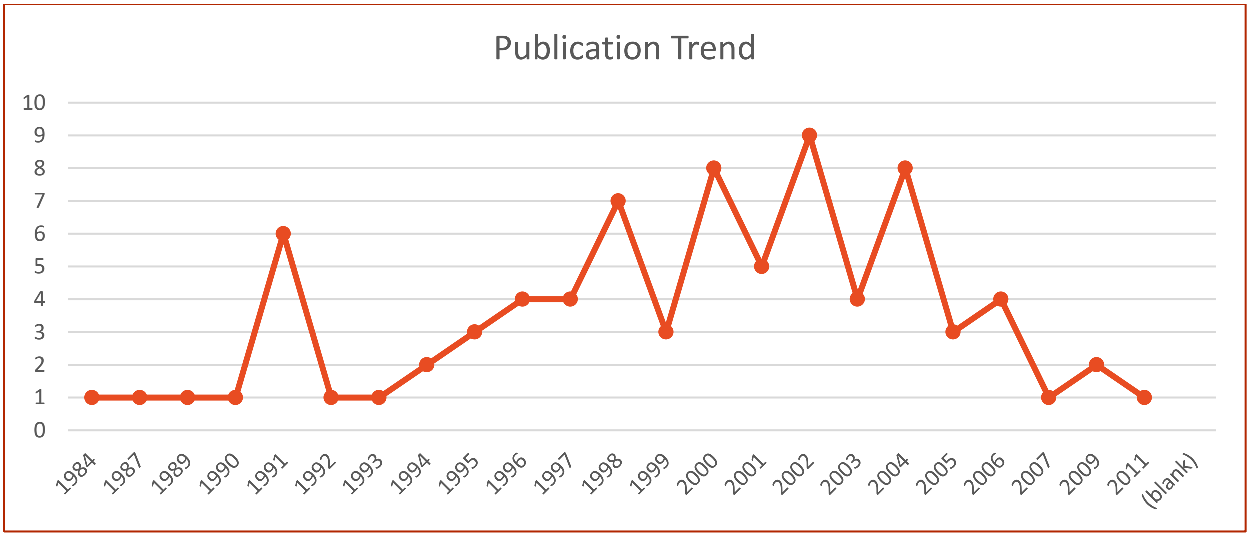
Key Companies

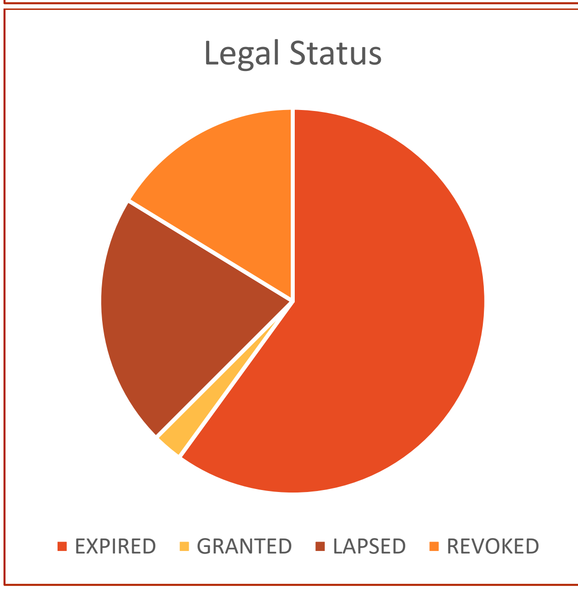
Canon

In the 1980s and 1990s, Canon pioneered research in the Multijunction solar cell technology domain, with a primary focus on PIN-type solar cells, particularly those using amorphous silicon and Group IV elements. Their efforts centered on developing processes and apparatus for manufacturing these cells, including methods for continuous treatment, such as roll-to-roll processes and multi-chamber deposition techniques. Canon filed approximately 80 patents between 1980 and 2004, covering various aspects of the manufacturing process and materials used in producing these PIN-type solar cells. However, as research advanced and heterojunction solar cells gained prominence, Canon shifted its focus away from PIN-type cells. Consequently, nearly 95% of Canon's patents in this area have expired and are no longer active.

In June 2024, Canon announced a breakthrough in perovskite solar cell technology, unveiling new materials that enhance durability and stability in mass production. This material allows for a thicker coating of the perovskite layer, ranging from 100-200 nm, while maintaining high photoelectric conversion efficiency—something previously challenging with conventional materials. In collaboration with Professor Dr. Tsutomu Miyasaka, the inventor of perovskite solar cells, Canon conducted performance evaluations that confirmed the material's potential to significantly improve the durability and stability of perovskite solar cells. The company plans to begin mass production of these advanced solar cells in 2025. [Image Source: Canon]







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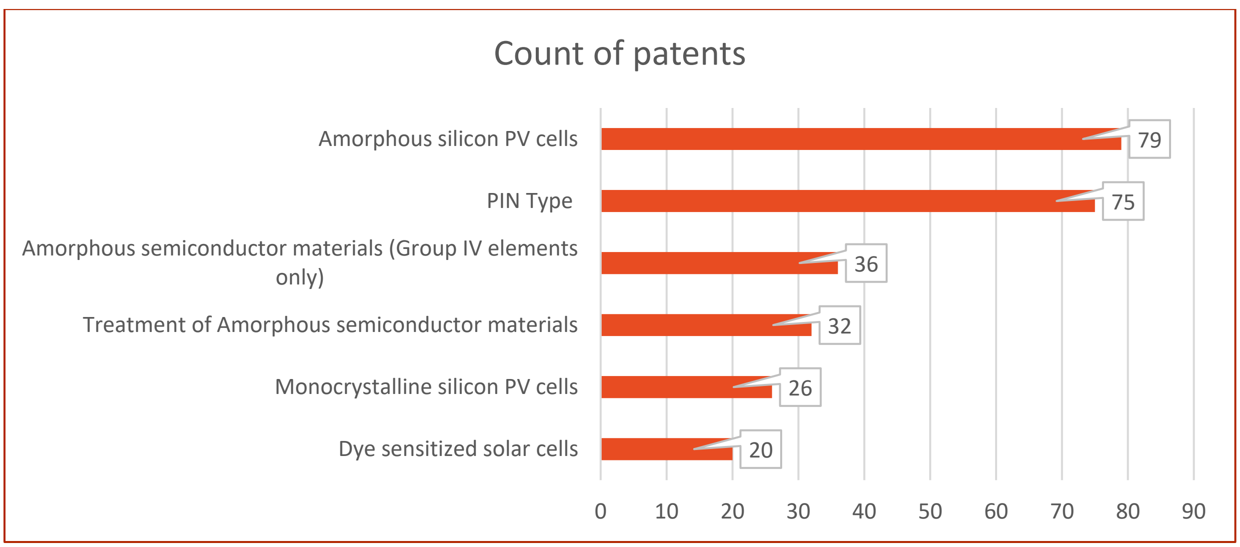
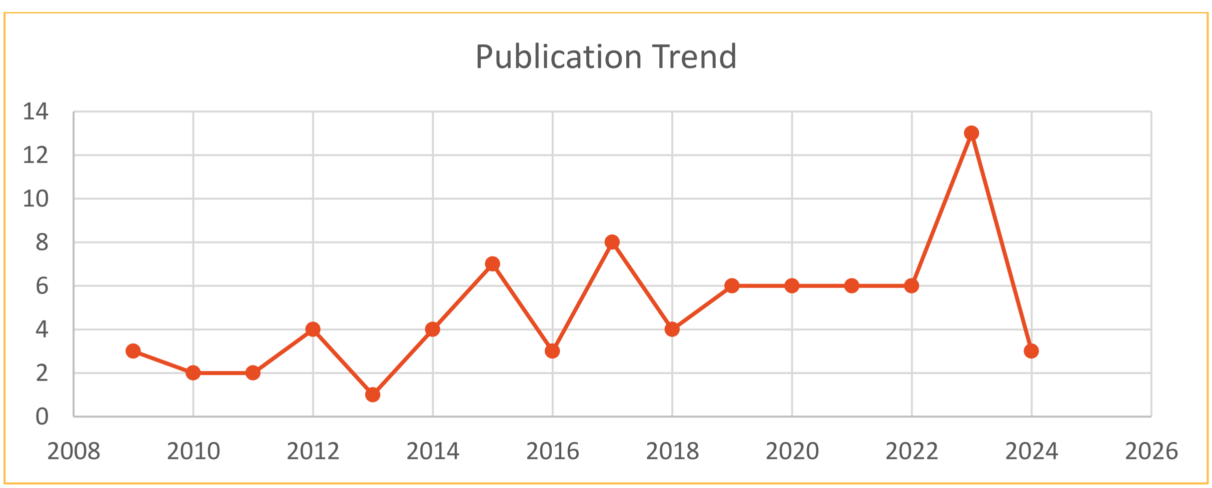


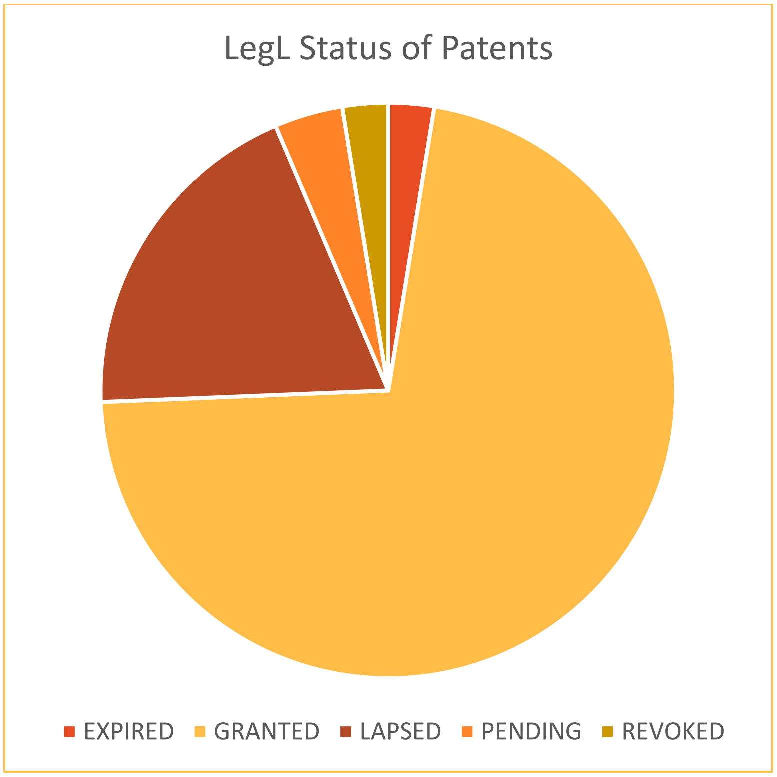
SolAero specializes in the development of vertically integrated space solar Photovoltaic Array (PVA) panel products, tailored for specific missions to LEO, MEO, GEO, and interplanetary applications. Additionally, SolAERO manufactures composite panel substrates. In 2022, Rocket Lab acquired SolAERO Technologies.

SolAERO is a leading developer of high-efficiency Multijunction solar cells, primarily focusing on Group III-V materials, particularly ternary and quaternary compounds such as Ga Al As and In Ga As P, for advanced applications in spacecraft and satellites. SolAero patented technologies are compatible with both homojunction and PN heterojunction solar cells. In the area of PN homojunctions, SolAERO has concentrated on inverted grown metamorphic (IMM) multiple junction solar cells, specifically those utilizing III-V compounds.

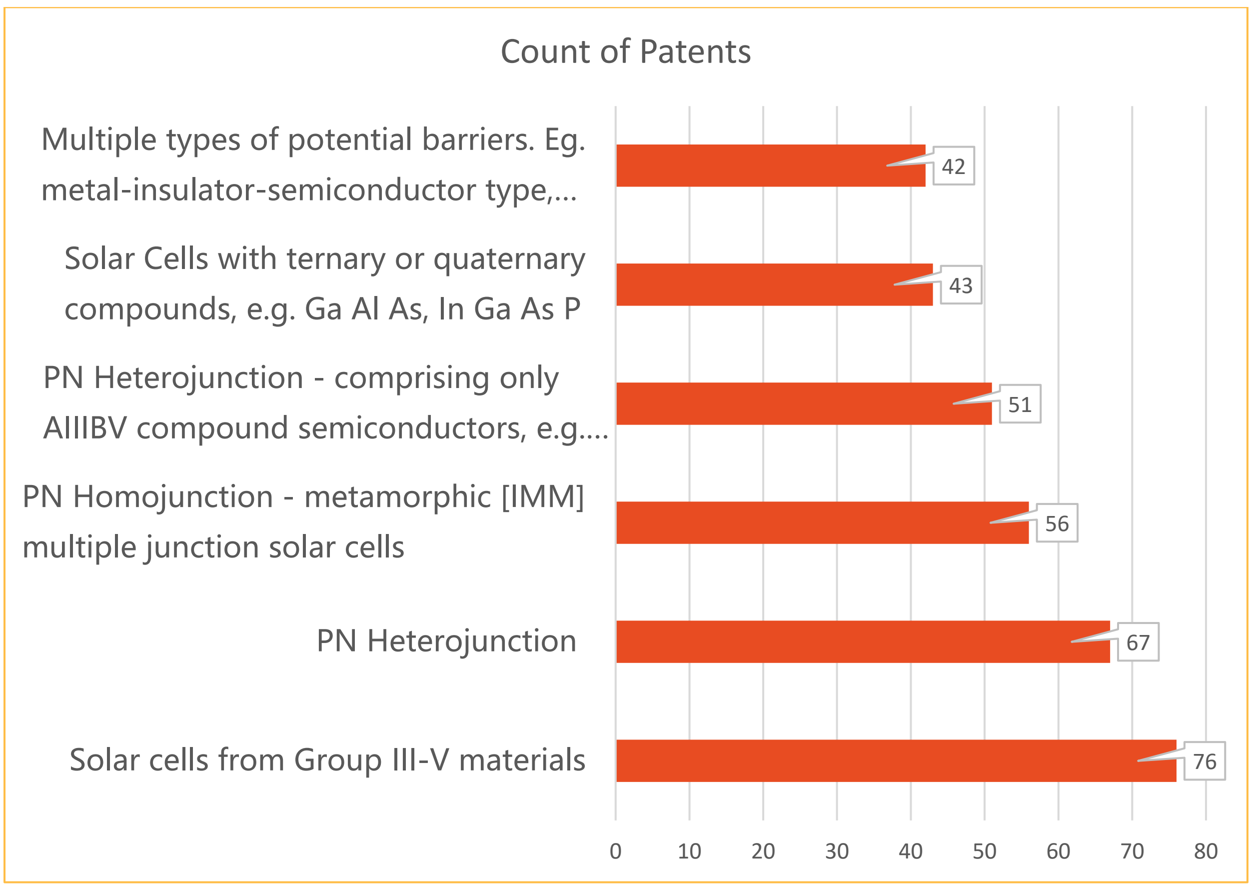
The company's patent activity in MJSC began in 2006 and has continued to grow, with a notable increase in filings in 2015 following the acquisition of EMCORE Corporation in 2014. EMCORE, a leader in compound semiconductor-based components and co-owns approximately 80% of SolAERO's patents.

In 2024, Rocket Lab secured approximately $24 million in federal funding aimed at significantly enhancing the production of compound semiconductors.





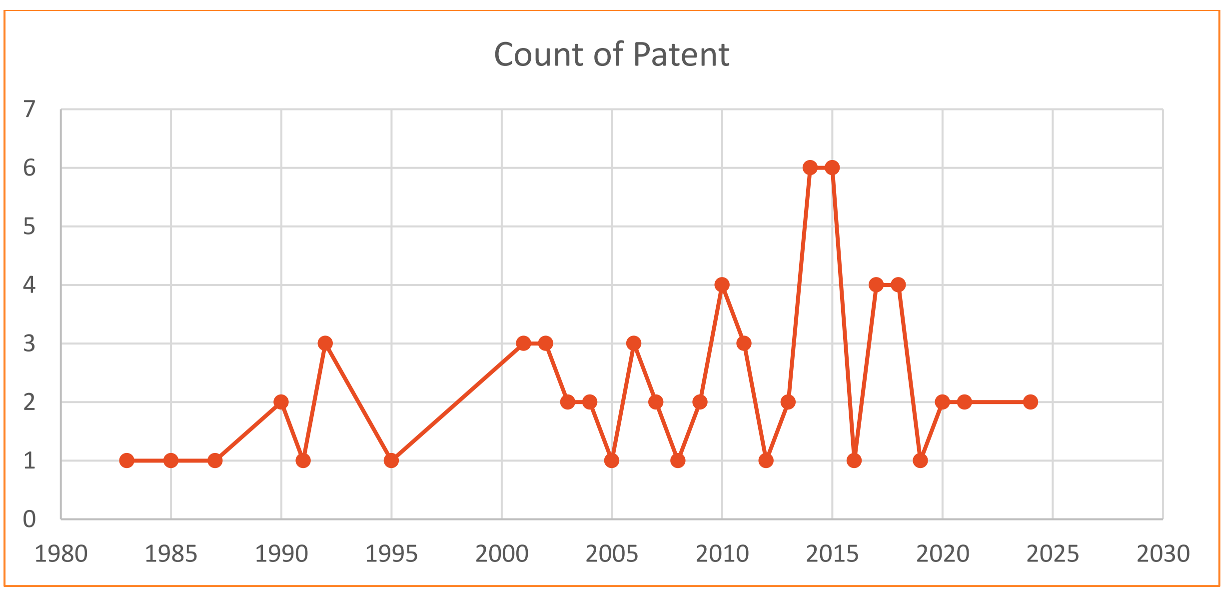
Most of the Patents Assigned to SolAero are active and granted. SolAero patented technologies are compatible with both homojunction and PN heterojunction solar cells. In the area of PN homojunctions, SolAERO has concentrated on inverted grown metamorphic (IMM) multiple junction solar cells, specifically those utilizing

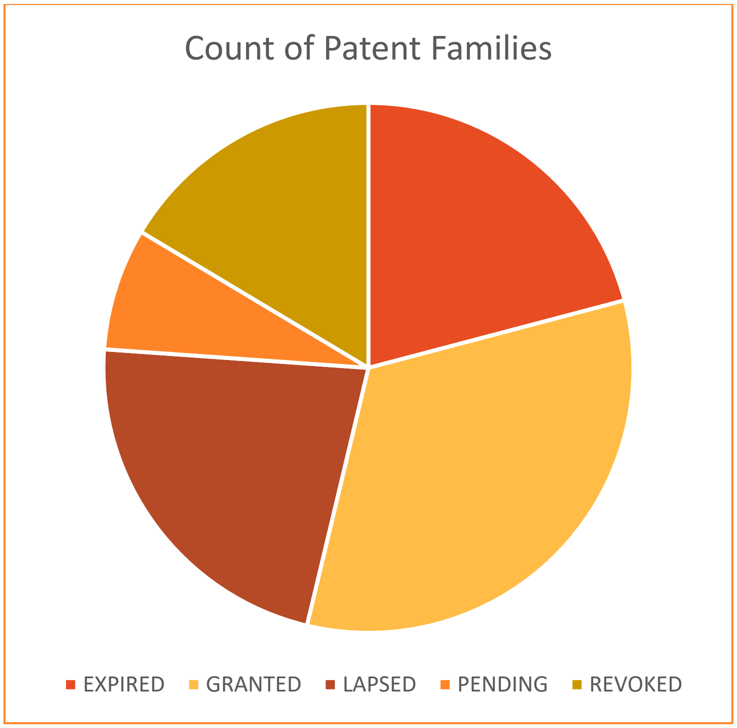


Japan based Kaneka Corporation began patenting Multijunction Solar cells in the 1980s, initially filing a few patents. However, patenting activity and news reports indicate that the company's R&D efforts accelerated in the late 1990s. Since then, Kaneka has consistently filed 3-4 patents annually, focusing primarily on monocrystalline silicon PV cells. Their research is predominantly concentrated on amorphous silicon PV cells.

In 2017, Kaneka Corporation introduced a groundbreaking silicon-based solar cell with a record-breaking efficiency of 26.3 percent. This surpassed the previous record of 25.6 percent efficiency, while most commercial solar cells typically achieve around 20 percent.

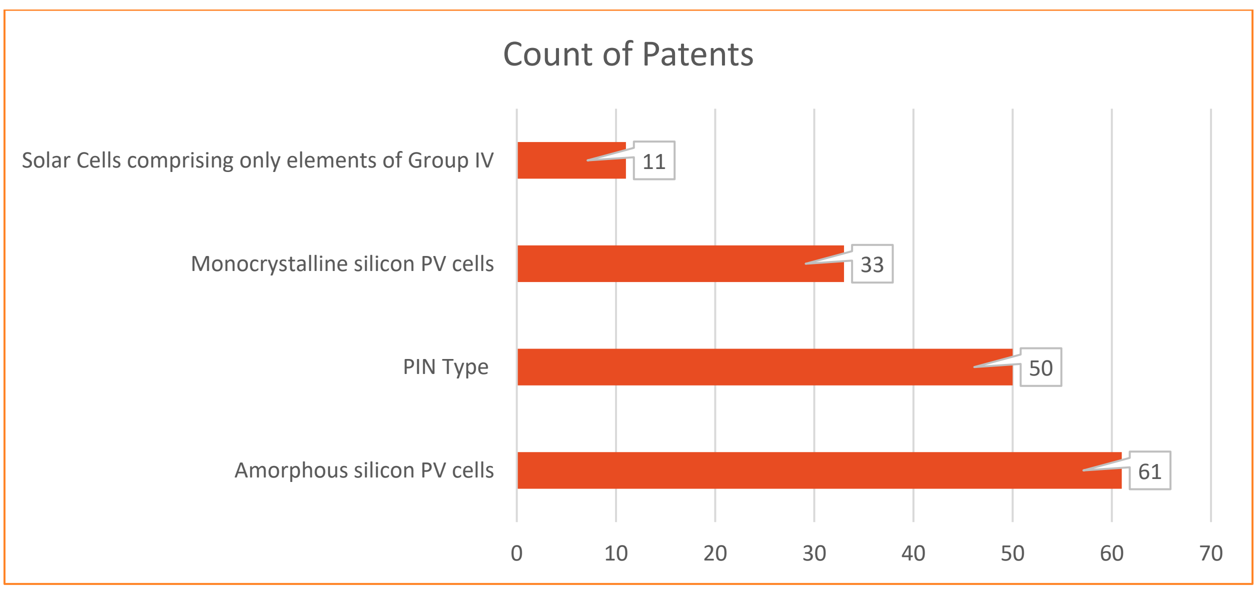
In 2023, Kaneka unveiled a two-terminal tandem perovskite solar cell, claiming it has achieved the highest efficiency recorded for such a device using an industrial Czochralski (CZ) silicon wafer. The cell boasts an open-circuit voltage of 1.929 V, a short-circuit current density of 19.5 mA cm−2, and a fill factor of 77.55%. Toyota has shown significant interest in Kaneka's technologies, incorporating these solar cells into its Prius model.





Patent analysis reveals that Kaneka began filing patents in the multijunction solar cell domain in the early 1980s when the technology was first emerging. Since then, Kaneka has consistently pursued research aimed at improving the efficiency and performance of solar cells, particularly those using amorphous silicon.

The company appears to have a strong focus on monocrystalline silicon-based solar cells, which have gained significant traction within the Japanese industry. Most of the patents in Kaneka's portfolio remain active, with a considerable number still under application, underscoring their ongoing innovation in this field.



Recent Mergers and Acquisitions

5N PLUS

April 15, 2021: In 2015, Canada-based high-purity metals and compounds provider 5N Plus agreed to acquire Germany's Azur Space Solar Power GmbH for approximately €79 million. Azur Space, a manufacturer of multi-junction solar cells for space and terrestrial concentrated photovoltaic (CPV) applications produces triple-junction space solar cells with an average efficiency of up to 30% and is aiming to develop ultra-thin solar cells with efficiencies of up to 35%.

October 10, 2021: Reliance Industries of India, through its subsidiary Reliance New Energy Solar Ltd, acquired the Norwegian solar energy firm REC Group for $771 million. The REC Group's is actively collating advanced technology and manufacturing capabilities to power Reliance's upcoming Gigafactory, which will be dedicated to the large-scale manufacturing of solar panels and cells.

First Solar.

In May 2023, First Solar, a major U.S. solar module manufacturer, acquired Swedish manufacturing startup Evolar AB for an initial payment of $38 million, with an additional $42 million to be paid contingent upon achieving certain technical milestones. Evolar specializes in the development of high-efficiency tandem photovoltaic (PV) technology and this acquisition is intended to accelerate next-generation solar technology, including tandem devices that combine thin-film and silicon technologies.

In Aug 2023 Waaree Energies of India raised approximately $120.88 million in its second round of funding to expand Waaree's manufacturing capacity by an additional 6 gigawatts (GW), increasing its total capacity to 18 GW. With this expansion, Waaree aims to manufacture solar ingots, wafers, cells, and modules, further solidifying its position as a leader in the Indian solar industry.

In September 2023, Maxeon Solar Technologies acquired selected assets from Complete Solaria. The acquisition includes Solaria's dealer channel operations, contracts, and a significant solar patent portfolio related to shingled cell solar panel technology. Maxeon, views this acquisition as an opportunity to strengthen its intellectual property portfolio, which includes over 130 granted patents and more than 80 pending patent applications.

In October 2023, Qcells completed the acquisition of full ownership of the intellectual property rights for LECO technology, which is known to enhance the efficiency of PERC (Passivated Emitter Rear Cell) and TOPCon (Tunnel Oxide Passivated Contact) solar cells. This acquisition has strengthened Qcells competitive position in the solar industry by integrating LECO technology into its product lines.

In August 2024, Tongwei, a vertically integrated solar manufacturer in China, presented a CNY 5 billion ($698.9 million) offer to acquire Chinese solar module maker Runergy. This transaction, if successful, would be the largest M&A deal in the photovoltaic (PV) sector in 2024. This acquisition is expected to significantly enhance Tongwei's production capacity and market presen ce in the global solar industry.

Future and scope of Multi-junction solar cells (MJSCs)

Increasing Efficiency for Space Applications

- As the space industry continues to grow, particularly with satellite constellations and deep-space missions, MJSCs will play a critical role due to their superior efficiency and ability to operate in extreme environments. Their high energy conversion rates make them ideal for powering spacecraft with limited surface area for solar panels.

Advancements in Concentrated Photovoltaics (CPV)

- The future of MJSCs lies in concentrated photovoltaic systems, where sunlight is focused onto a small area of high-efficiency MJSCs using lenses or mirrors. This technology has potential for large-scale solar farms, where maximizing energy output in a smaller footprint is crucial.

Cost Reduction and Commercial Viability

- As research progresses and manufacturing techniques improve, the cost of producing MJSCs is expected to decrease. This could enable wider commercial adoption in terrestrial solar power systems, particularly in niche markets requiring high-efficiency solutions, such as remote areas or high-density urban environments.

Emerging Materials and Tandem Cell Integration

- Ongoing research into new semiconductor materials, such as perovskites, holds promise for next-generation MJSCs. Combining MJSCs with emerging technologies like perovskite tandem cells could lead to even higher efficiencies and more cost-effective production, expanding their use in mainstream solar energy markets.

About us

IIPRD is a premier and well-established Intellectual Property (IP) Asset Management Firm focusing on Comprehensive Patent Support Services ranging from Patent Searching, Patent Prosecution/Preparation, to Litigation/Licensing Support Global Corporates and Law Firms.

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