



Aiko ABC Modules

Technical White Paper



The Birth of ABC Modules

Deeply engaged in photovoltaics (PV) cell technology for many years, Aiko has an industry-leading Research and Development (R&D) and manufacturing technology for PV cells, which is widely recognized by global crystalline silicon module enterprises. Facing the situation that the conversion efficiency of mainstream Passivated Emitter and Rear Cell (PERC) cell technology is close to the theoretical limit of mass production efficiency, the pressing demands for new energy development both domestically and internationally as well as the severe competition of the industry, Aiko has developed All Back Contact (ABC) cell technology with completely independent intellectual property rights, featuring extremely high open-circuit voltage, current and efficiency, as well as extremely low-temperature coefficient, module working temperature, and excellent module reliability.

To fulfill the concept of green development and contribution to carbon emissions peaking and carbon neutrality goals, Aiko ABC was born. With the strong support of ABC cell technology, the module R&D team focuses on the PV industry "pain points", such as increasing power output, reducing loss and balance of system (BOS) cost. With the module concept of high performance and high reliability, ABC modules contain two series, "Black Hole" and "White Hole" series, with the maximum module conversion efficiency of up to 24% and the maximum power output of 72-cell M10 module (AIKO-A-MAH72Mw) up to 620W.



445w~460w
AIKO-A-MAH54Mb



595w~615w
AIKO-A-MAH72Mb



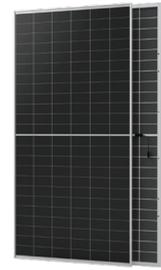
450w~465w
AIKO-A-MAH54Mw



600w~620w
AIKO-A-MAH72Mw



440w~455w
AIKO-A-MAH54Db



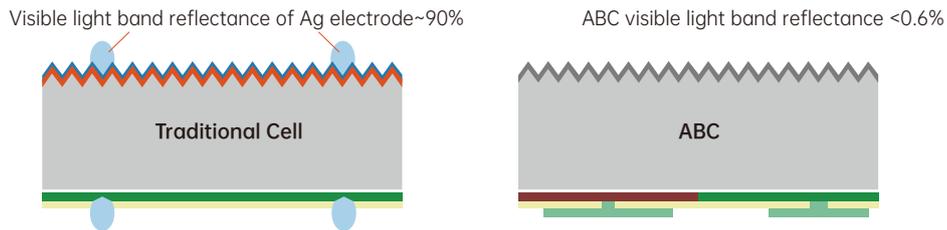
595w~615w
AIKO-A-MAH72Dw

Module Model	Module Power	Module Efficiency	Module Dimension
AIKO-A-MAH54Mb	445w~460w	23.6%	1722*1134*30
AIKO-A-MAH72Mb	595w~615w	23.8%	2278*1134*35
AIKO-A-MAH54Mw	450w~465w	23.8%	1722*1134*30
AIKO-A-MAH72Mw	600w~620w	24.0%	2278*1134*35
AIKO-A-MAH54Db	440w~455w	23.3%	1722*1134*30
AIKO-A-MAH54Dw	445w~460w	23.6%	1722*1134*30
AIKO-A-MAH72Dw	595w~615w	23.8%	2278*1134*30

Exploration of Extreme Efficiency of ABC Crystalline Silicon Cells

▪ All-area Light-absorption

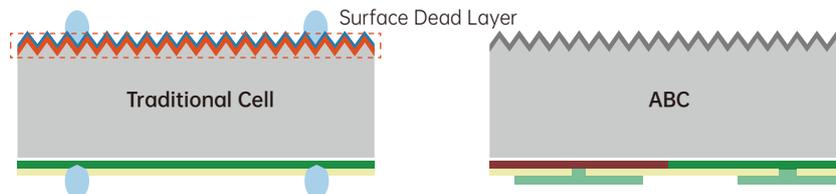
ABC cell has, no shading loss on the front side, bringing higher module conversion efficiency; extreme light absorption, forming a "black hole" for light absorption; no electrode on the cell's front side, thus no snail track.



Schematic Diagram of Traditional/ABC Cell Structure: Shading on the Front Side

▪ All-silicon Atomic Electricity Generation

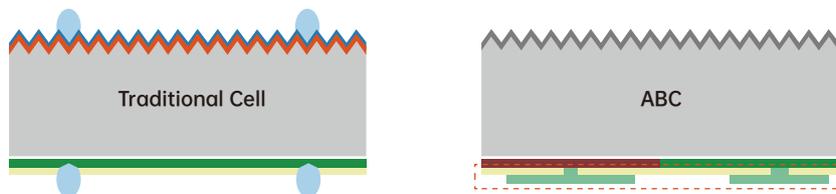
Traditional cell structure uses high-temperature diffusion, and a highly-defective layer called "dead layer" is formed. The electron-hole pairs generated by light absorbed by silicon atoms near the dead layer are quickly annihilated, which cannot contribute to electricity generation. However, all surfaces and interiors of ABC cells are passivated with high quality passivation technique, while the "dead layer" introduced by high doping is eliminated to achieve all-silicon atomic electricity generation.



Schematic Diagram of Traditional/ABC Cell Structure: Dead Layer

▪ All-back Electrodes

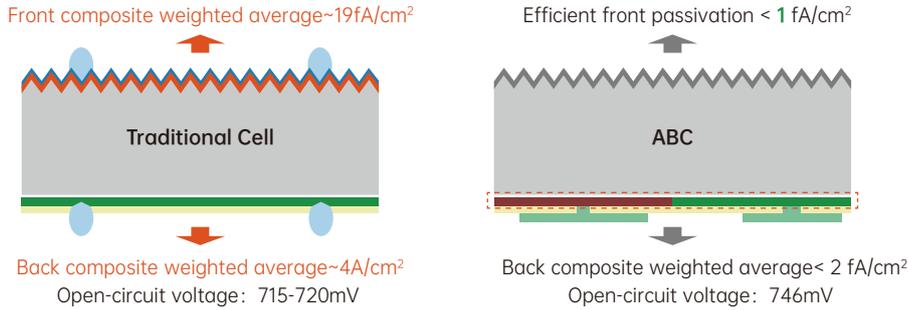
For the front side electrode width of traditional cell products, there is a contradiction between resistance and shading, resulting in the electrode being unable to effectively transmit current. All-back electrode design is adopted for ABC cell to break through the resistance/shading contradiction. Through the self-owned patent design, heating loss of electrode resistance is reduced by 60%.



Schematic Diagram of Traditional/ABC Cell Structure: Back Electrode

■ All-back Passivated Contact

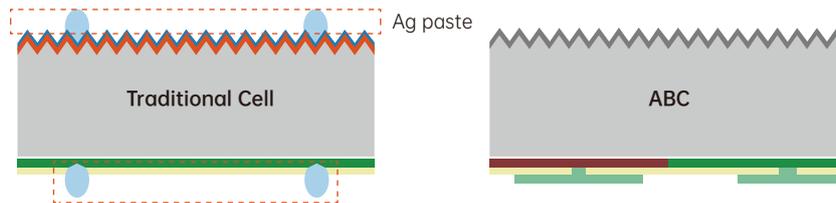
ABC cell owns an all-back contact technology with patent, which put emitter/base both on the back side of ABC cell. Compared to the traditional cell structure, the surface recombination is reduced by 87%, the open-circuit voltage exceeds 746mV, resulting in excellent temperature coefficient performance.



Schematic Diagram of Traditional/ABC Cell Structure: Surface Passivation

■ All Silver-free Metallization

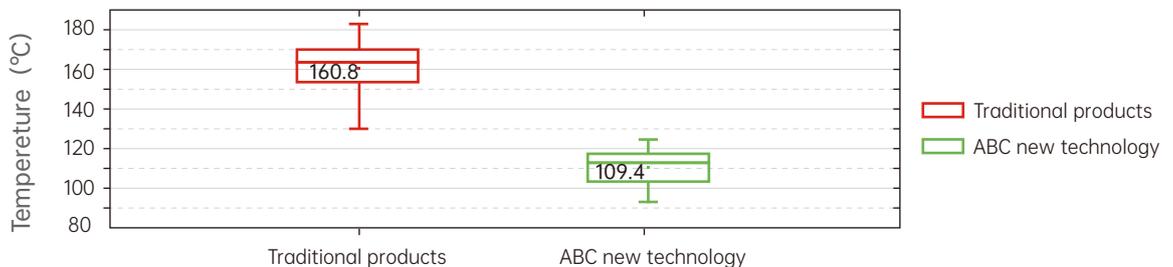
For traditional cell products, Silver(Ag) is used at least on the front side, due to the fact that the tensile force per unit area of non-Ag metallization is not good (in terms of reliability), and the front side metal area is in contradiction with shading. The patented Ag-free technology is adopted for ABC cell design, with 0% Ag content involved in cell process and all metals used to be low-cost metals. In addition, excellent acid corrosion resistance is shown with the average degradation of acetic acid soaking of ABC cells being less than 0.25%_{rel}, and that of Ag paste products being more than 1.5%_{rel}.



Schematic Diagram of ABC/Traditional Cell Structure: Metallization

■ All Lifecycle Hot Spot Risk Control

The new ABC module with 72-cell reduces the hot spot temperature by 50°C compared to the traditional structure, while reducing the frequency of diode start-up and slowing down the ageing of the junction box. In the future, continuous optimization will be achieved with the hot spot temperature expected to be less than 100°C. The module power yield will gain more than 40% with single cells or single cells of individual strings shaded.



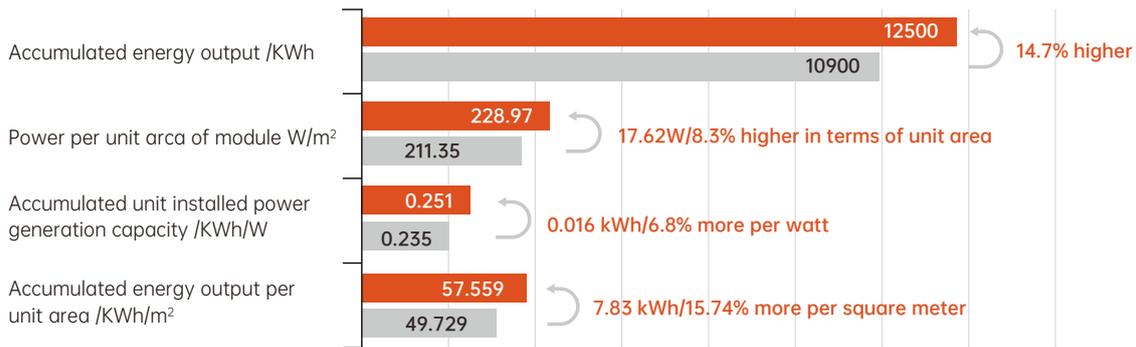
Hot Spot Temperature Test Results after 1 Hour of Stable Shading on a Single Cell

Customer Values of ABC Modules

High Power Output

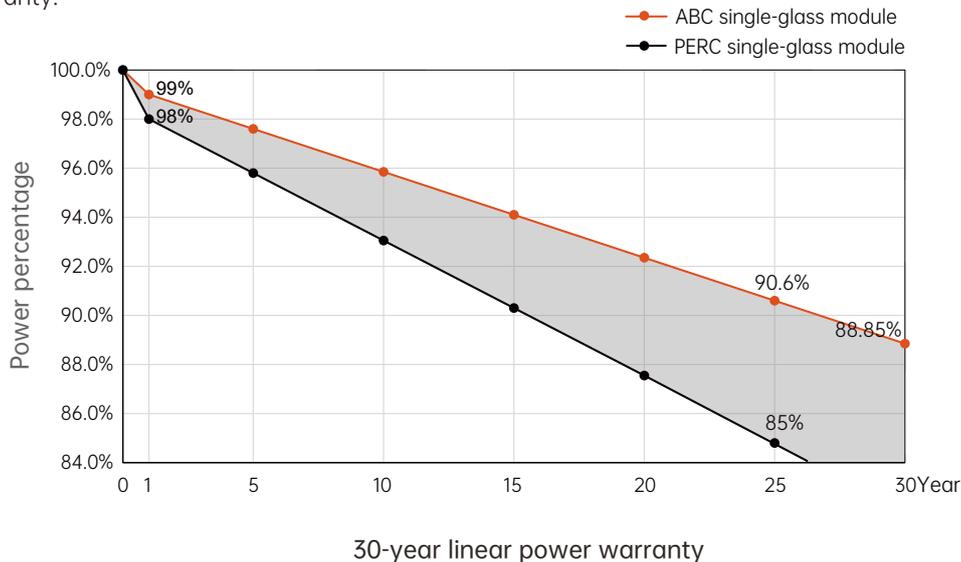
As ABC module efficiency reaches 24%, which is much higher than that of traditional modules (21.6%), and without gridlines on the front side of the cell, ABC module is more conducive to absorbing sunlight and improving power generation performance when light is obliquely incident. Meanwhile, ABC module has a lower temperature coefficient than the traditional module, i.e. $-0.278\%/^{\circ}\text{C}$ for ABC module and $-0.34\%/^{\circ}\text{C}$ for the traditional module, resulting in more significant power generation benefits in hot weather. The following is the actual power output of ABC module and traditional module of the 1.05MW Distributed PV Power Station Project in Wanshangyu in Anhui province in China (statistical period: Dec 30, 2022 to Apr 13, 2023):

- 1, Under the same land area, the power per unit area of ABC module is 8.3% more than that of traditional module.
- 2, Comparing the unit installed power generation capacity in the same environment and time period, ABC module generates 0.016 KWh more electricity per watt than traditional module, which is 6.8% more.
- 3, In the cumulative period, the power generation per unit area of ABC module is 7.83 KWh more than that of traditional module, which is 15.74% more.



High Quality Assurance

High-quality N-type silicon wafers and optimized ABC technology are used for ABC modules. The power degradation of ABC modules in the first year is no more than 1%, and that in the following year is no more than 0.35%, providing a 30-year linear power output warranty.



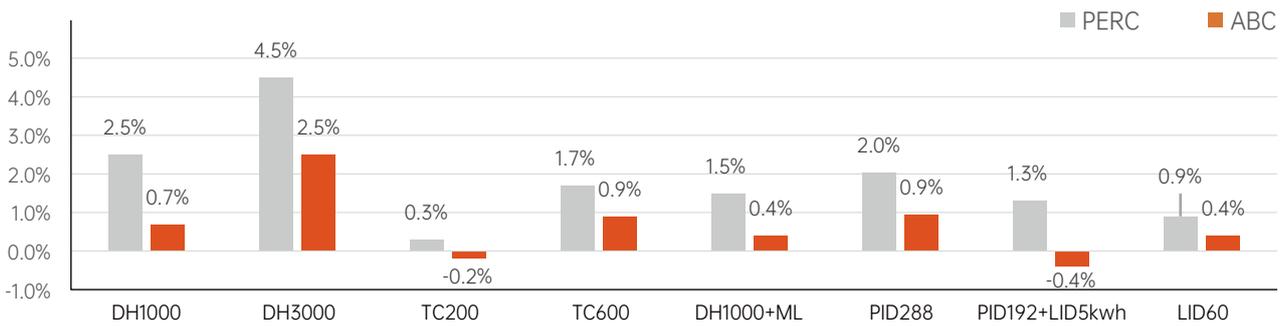
■ High Reliability

Aiko has established module reliability testing standards that are two to three times more rigorous than the IEC standards, so as to ensure product reliability.

Test Items	IEC 61215/61730 Standard	Aiko Standard
Damp heat	1000 hours	3000 hours
Heat cycle	200 cycles	400-600 cycles
PID	96 hours	288 hours
Humidity-freeze cycle	10 cycles	20-30 cycles

The test results show that compared with traditional products, ABC modules are significantly more reliable, positioning at the leading level in the industry.

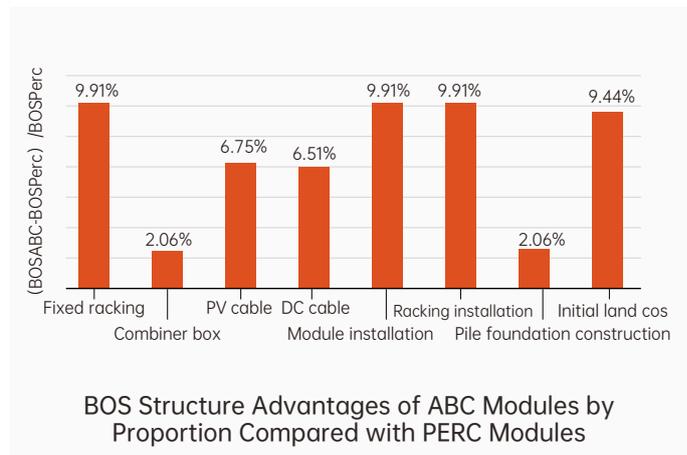
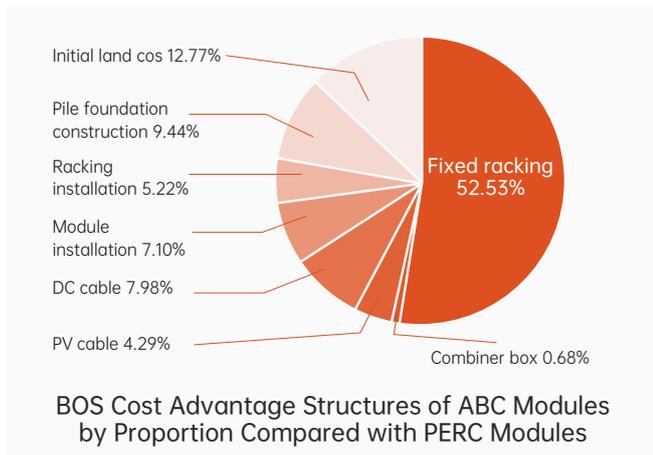
Taking the damp heat test as an example, after a test time of 3000 hours (three times than the IEC standard), the power degradation of ABC modules is less than 2.5%, which is significantly lower than the indicator of less than 5% after 1000 hours of test specified in the IEC standard.



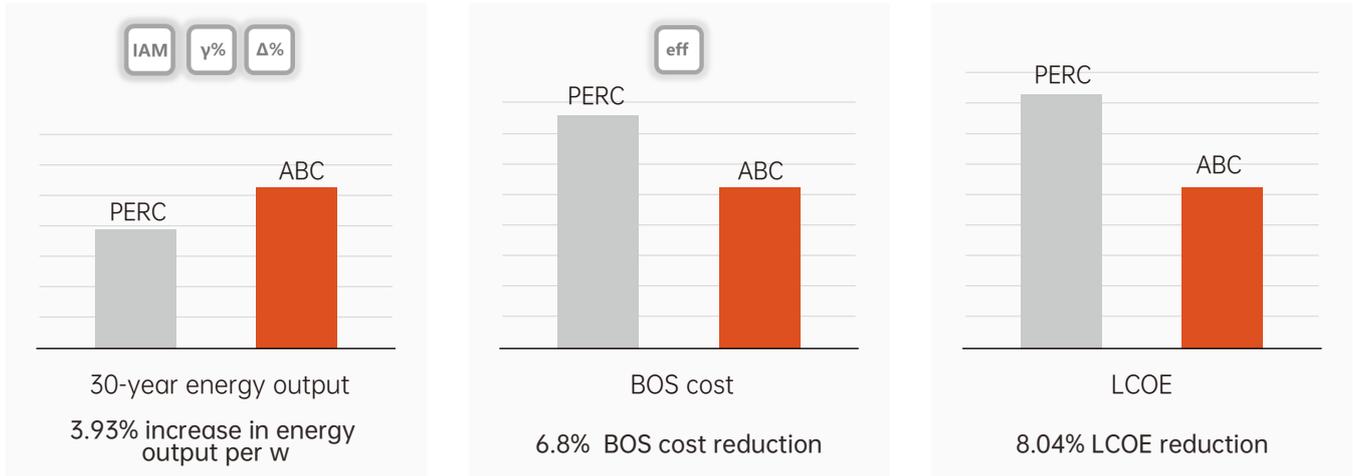
Comparison of Power Degradation between ABC Modules and PERC Modules after Test

■ Better BOS Cost and Lower LCOE Cost

ABC modules have higher power efficiency and better temperature coefficient, which means that fewer modules are needed for the same installed capacity. As a result, BOS cost of the power station will be lower. Based on the calculation of a 10 MW power station in Zhuhai in Guangdong province in China, the BOS cost of ABC modules is 6.8% lower than that of traditional modules.



Taking the 10 MW power stations in Zhuhai in Guangdong province in China as an example, assuming that the site area and installed capacity of the power station are the same, and that the installation method and system life are the same, the levelized cost of electricity (LCOE) of ABC modules can be reduced by 8.04% compared to traditional modules



*The relevant analysis is based on the calculation results of a 10MW system capacity power station in 30-year operation cycle in Zhuhai, Guangdong Province and TUV provides the ABC module panfile.

■ Aesthetic Consistency

ABC module of "Black Hole" series are perfectly suited to the needs of BIPV market. The front side of ABC cells has no metal gridlines, and the PN junction and corresponding positive and negative metal electrodes are arranged in an interdigitated pattern on the back side of the cell, which not only brings higher conversion efficiency to the cell, but also creates an ultimate appearance experience for the module.



Conclusion

While innovating in the core products of ABC module series, Aiko has also addressed issues related to product reliability, mass production equipment supply, raw material supply guarantee, and system matching through upstream and downstream collaborative innovation and synchronous R&D, to realize continuous optimization and rapid industrialization and application of ABC modules. Rooted in China with a global presence, Aiko adheres to the core value of being "customer-centered", focuses on scientific and technological innovation, deeply integrates energy technology and digital technology, concentrates on the core capabilities of solutions, provides customers with smart energy solutions featuring the integration of Generation-Grid-Load-Storage, continuously promotes the development of clean energy and the efficient utilization of traditional energy, benefiting various industries and numerous households with safe, smart, and low-carbon energy.



Find your power



Shenzhen Aiko Digital Energy Technology Co., Ltd.
Address: Room 607, Building B, Tengfei Industrial Building, No. 6, Taohua Road,
Fubao Community, Fubao Street, Futian District, Shenzhen
Website: www.aikosolar.com