



Suzhou YourBest New-type Materials Co., Ltd

责任 创新 高效

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C o n t e n t

1 Product Value

2 Core Advantages

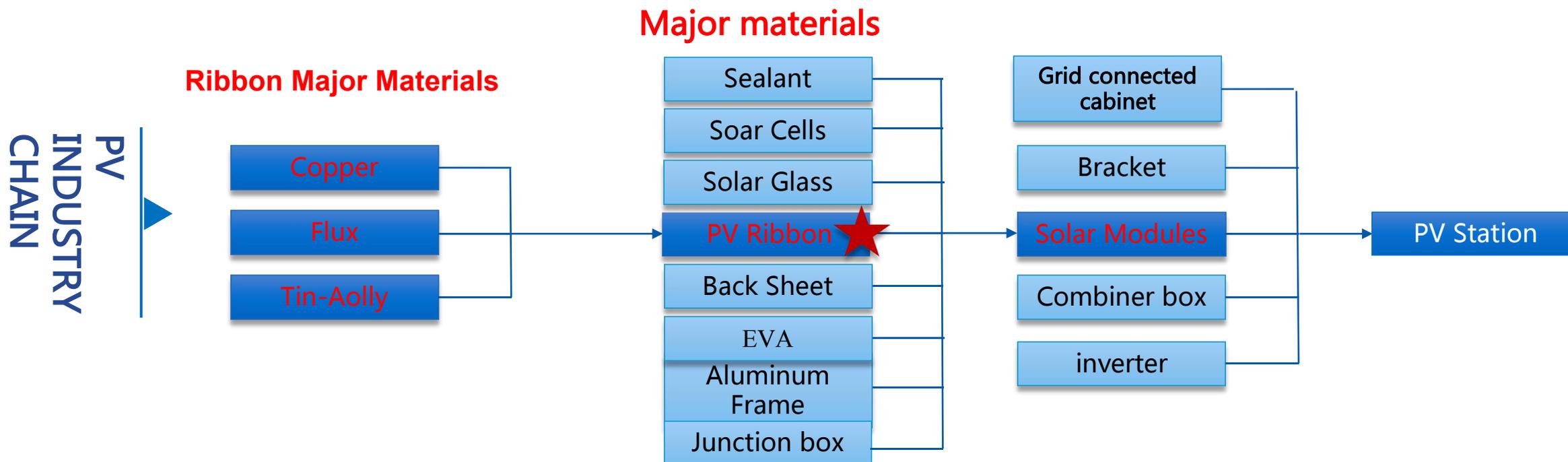
3 Company Introduction

Product

01 PV RIBBON

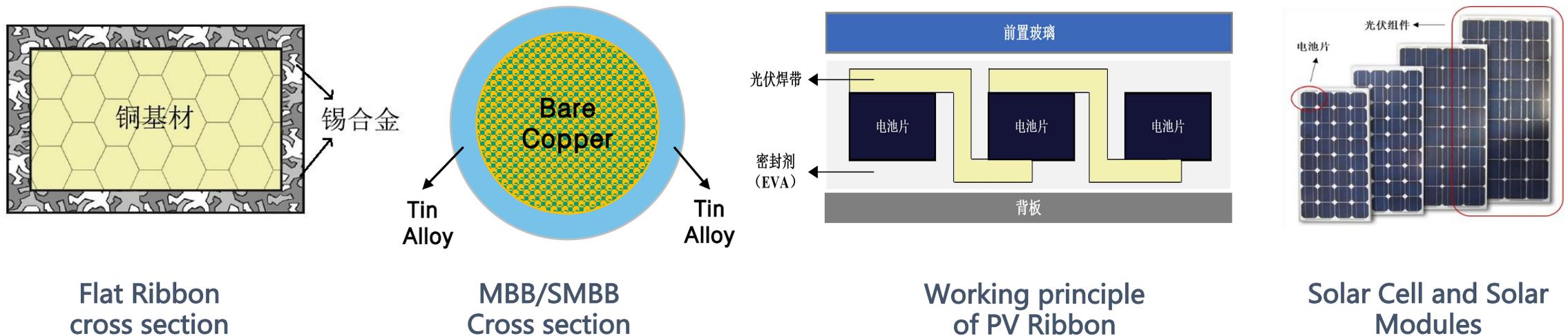
Major Business—PV Industry Chain

- Major Industry—Solar PV module used PV ribbon R&D, production and sales.
- Classify Industry based on China Securities Supervision Commission: Yourbest is listed in **PV equipment and component manufacture industry** (C3825)
- According to National Bureau of Statistics, PV equipment and component manufacture are **belonging new industries ,new formats and news business models.**

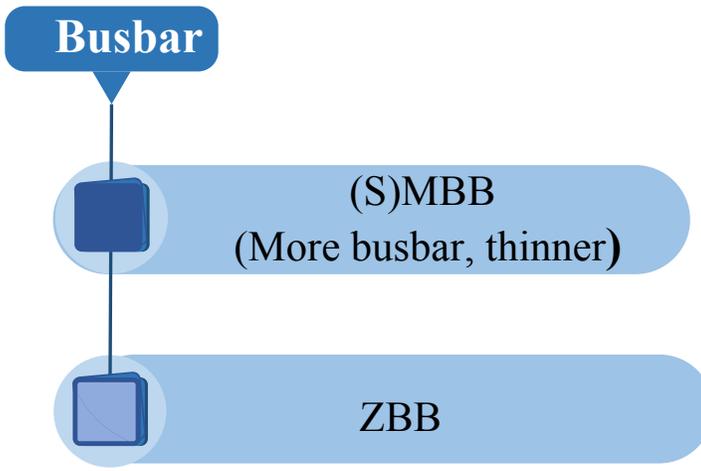
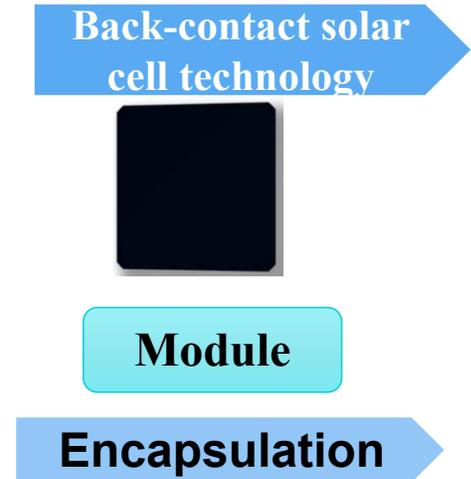
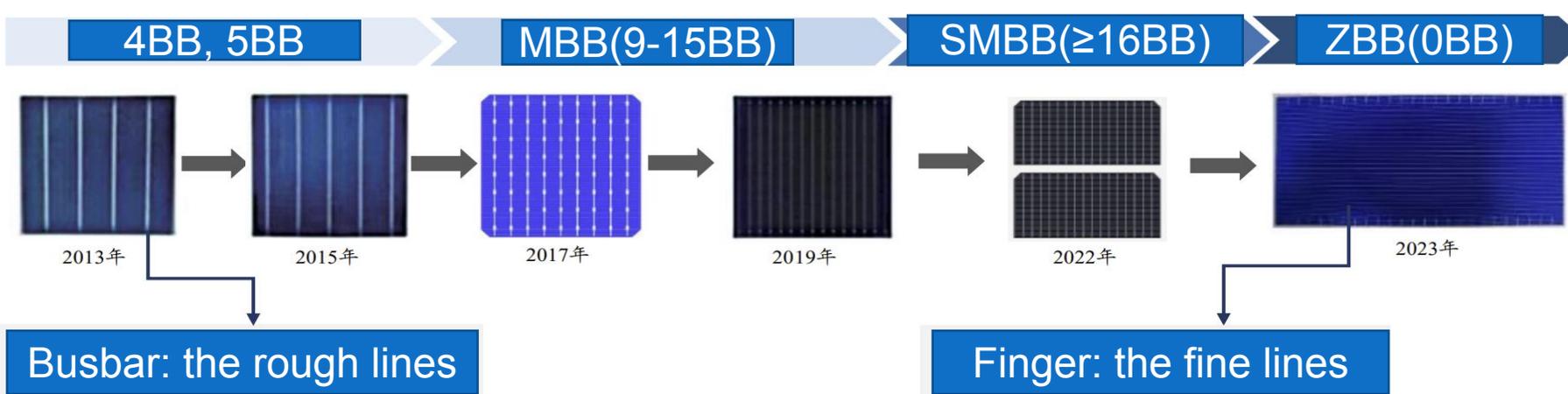


Major Products-Structure and Usage

- Major Products: PV Ribbon or tin-plate Ribbon, which **is applied in series or parallel connection of photovoltaic cells**, it plays an important role in conducting and concentrating electricity to enhance the output voltage and power of photovoltaic modules.
- The major structure of PV Ribbon is bare copper and tin-alloy. (1) Bare copper size is customized with. (2) The technology is hot-dipping. Using dipping method to plate tin alloy on the bare copper evenly.
- The Solar cells connected by PV ribbon. And be packaged together with other component materials such as EVA film, photovoltaic glass, back film, frame, etc. to form photovoltaic modules.

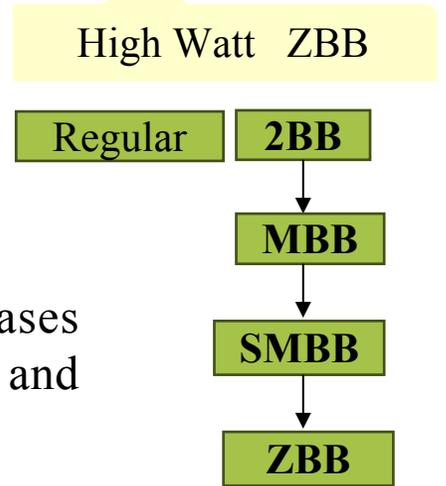


Development of Solar Cells Technology



Reducing the obstruction of sunlight by the surface and decreasing the amount of silver paste required in solar cell production

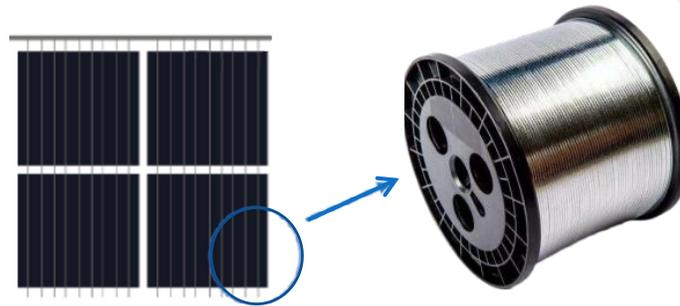
The ZBB technology further reduces silver usage, decreases the shaded area, ensures a more even current distribution, and enhances the module's power output.



1ST Generation——MBB Round Ribbon



Thinner than Regular flat interconnector ribbon, Effectively reduces the shading of the solar cells, while also making the current density distribution more uniform.



For PERC



Copper Materials : TU1 (≥99.97%)

Solder : Sn60Pb40、 Sn63Pb37

Concentricity

$$= \left(1 - \frac{\text{max thickness} - \text{min thickness}}{\text{max thickness} + \text{min thickness}} \right) \times 100\% \geq 60\%$$



- Low yield strength, high tensile strength
- Precise coating thickness control
- High concentricity
- Strong solderability

ITEM	Technical Requirement
Ribbon Size(mm)	∅0.35/∅0.32/∅0.30/∅0.29
Copper Size(mm)	∅0.32/∅0.29/∅0.27/∅0.26
Diameter (mm)	-0.005-0.015
Yield Strength (Mpa)	≤70
Tensile Strength (Mpa)	≥150
Elongation (%)	≥20
Average Thickness (mm)	0.015±0.003
Resistivity (Ω·mm ² /m)	≤0.0210

2ND Generation——SMBB Round Ribbon

MBB

VS

SMBB

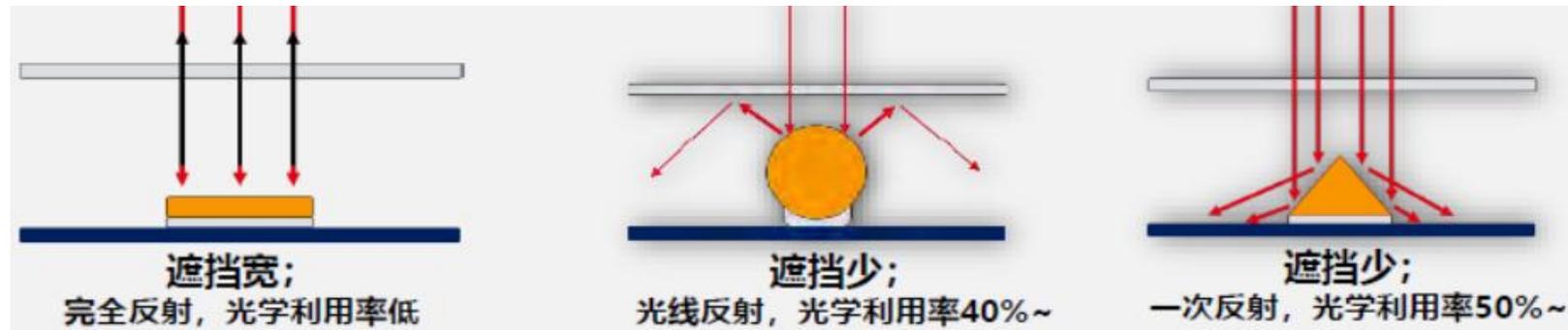
3BB

5-6BB

9-12BB

15-20BB

As the number of solar cell busbars increases, the specification of the interconnector ribbon becomes finer and finer.



Technical challenges of SMBB

For TOPCon

SMBB ($\varnothing \leq 0.26\text{mm}$)			
Ribbon Size (mm)	0.26	0.22	0.2
Thickness (Average) (um)	15~18	12~15	10~13
Yield Strength (Mpa)	60~70	65~75	70~80
Elongation (%)	$\geq 20\%$	$\geq 20\%$	$\geq 20\%$
Tensile Strength (Mpa)	≥ 150	≥ 150	≥ 150
Millicoulomb(g/m)	0.44~0.5	0.32~0.38	0.29~0.3
Milliohm ($\text{m}\Omega/\text{m}$)	380~410	510~540	630~660
Concentricity (%)	$\geq 50\%$	$\geq 40\%$	$\geq 40\%$

Precise coating thickness control

Challenge 1

Yield accuracy

Challenge 2

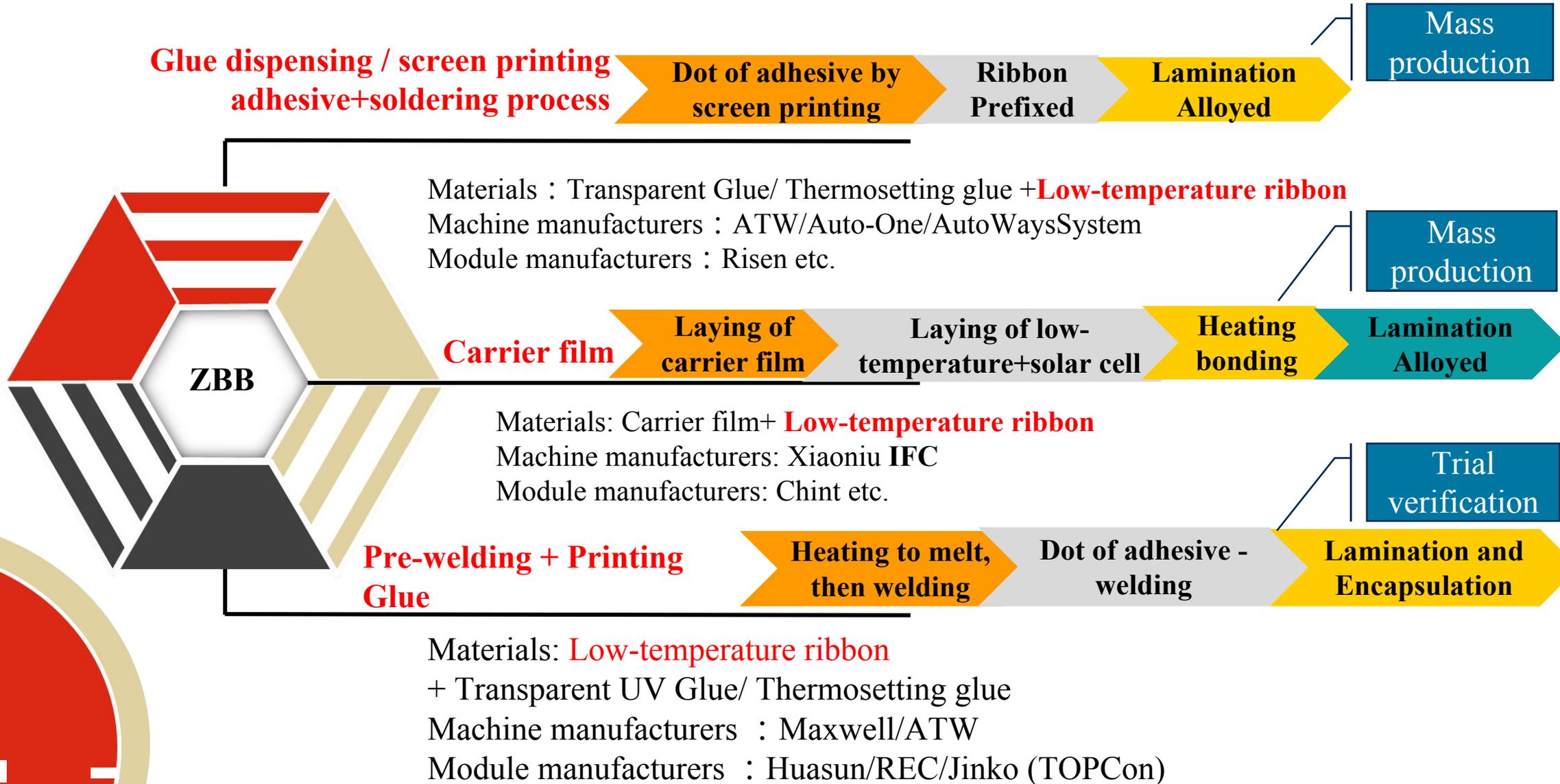


Challenge 3

Production Efficiency

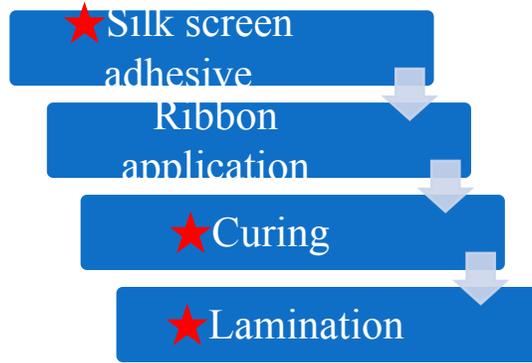
Challenge 4

Improvement in concentricity

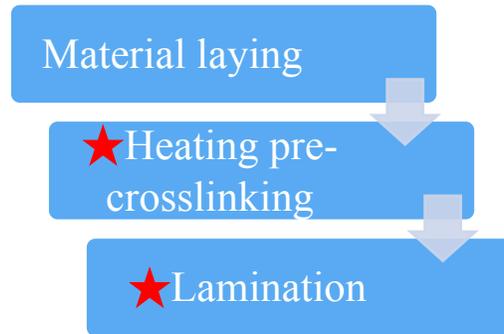


ZBB Technology Solution

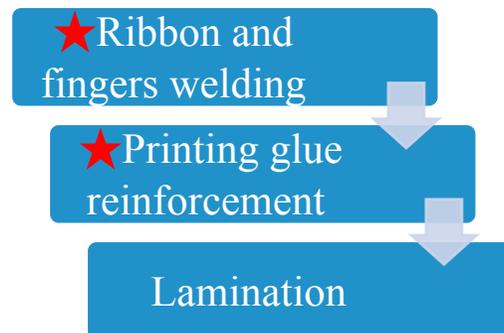
01 Glue dispensing/ screen printing adhesive+soldering



02 Carrier film

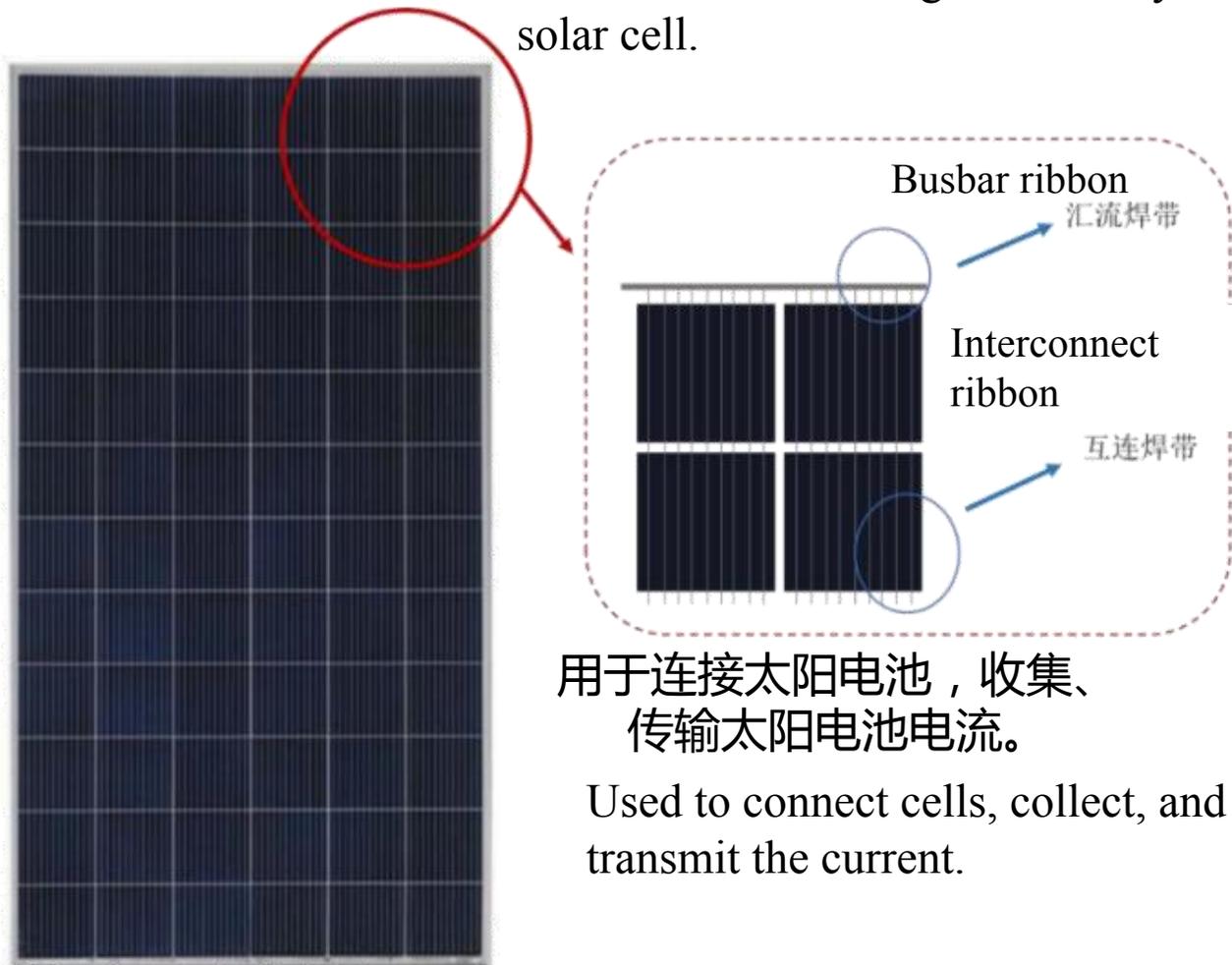


03 Pre-welding + Printing Glue



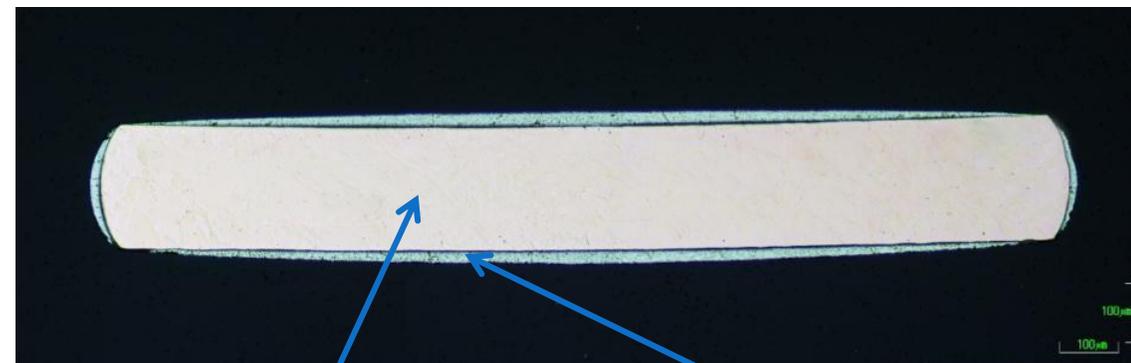
Structure of Low-temperature Ribbon

Busbar ribbon is used to connect solar cell strings to junction boxes and to transmit the current generated by the solar cell.



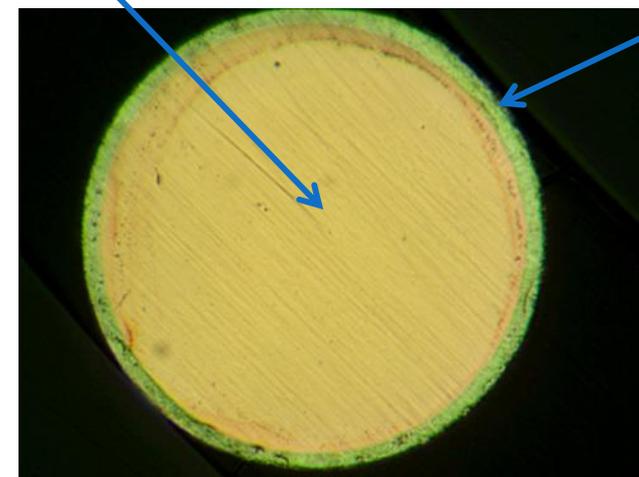
用于连接太阳能电池，收集、传输太阳能电池电流。

Used to connect cells, collect, and transmit the current.



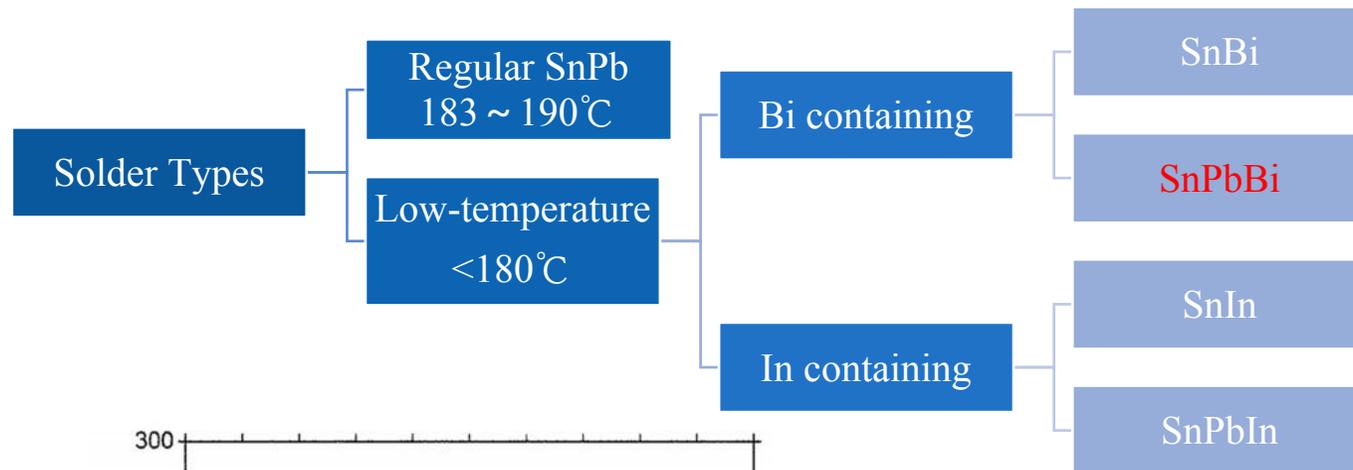
Copper

Low-temperature ribbon coating

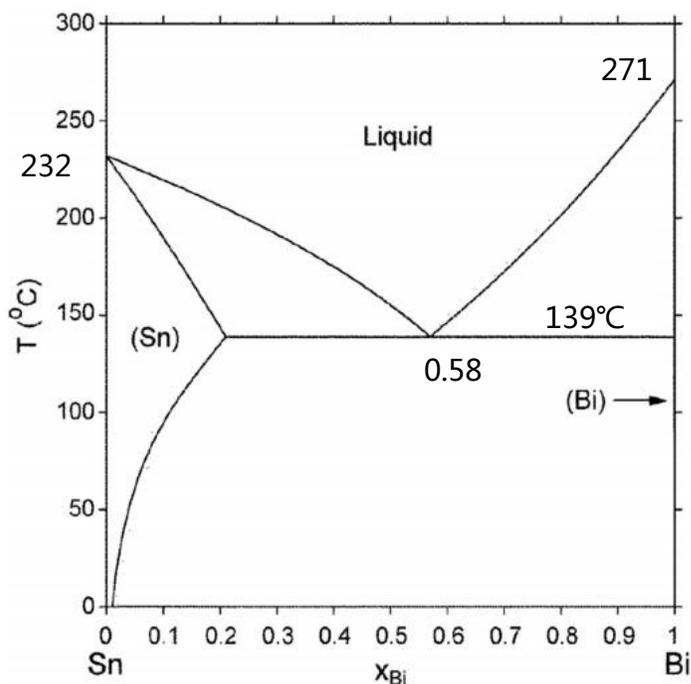


Ribbon for HJT module——Low-temperature ribbon

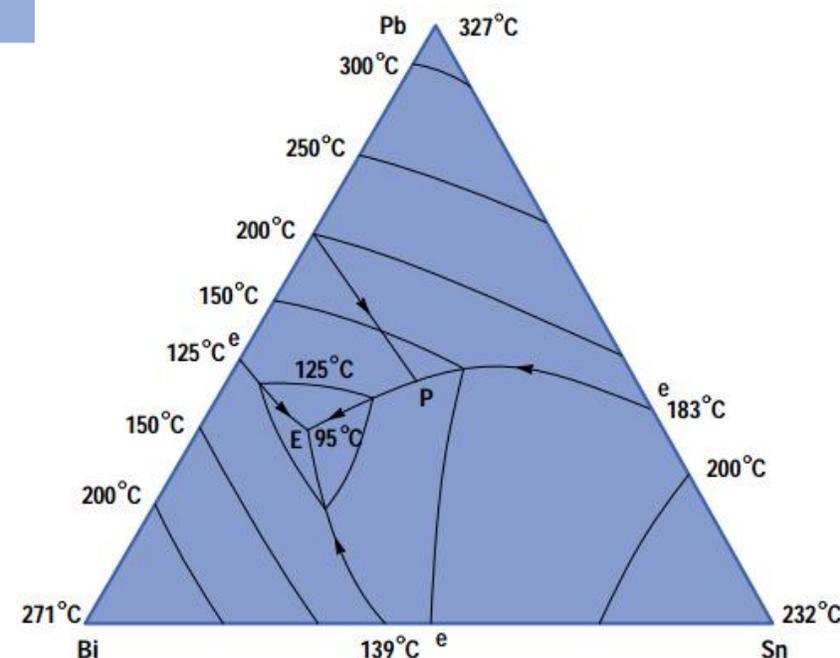
Alloy in the Solder of Low-temperature Ribbon



Indium, a rare metal with limited availability, is about 35 times more expensive than bismuth. Consequently, Bi is predominantly used as an additive in low-temperature ribbon due to its cost-effectiveness and availability.



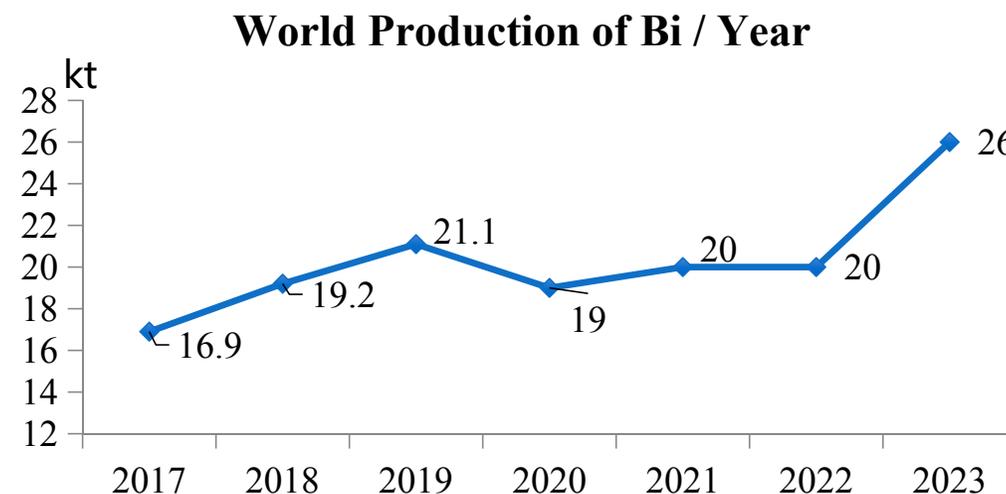
SnBi Phase Diagram



SnPbBi Phase Diagram

Alloy in Solder -Bismuth

Demand for bismuth in ZBB Module			
Capacity of ZBB , GW	Module Watt, W	The usage of low-temperature solder , kt (Calculation based on ø0.2)	The usage of Bi , kt (Calculation based on 30% Bi in solder)
100	460-750	22-29	1-2
200		44-58	3-4
500		110-145	7-9
1000		220-290	14-18



- The world's total bismuth reserves are approximately 370,000 tons, with the largest deposits found in China, Vietnam, Bolivia, Mexico, and Canada. China's reserves alone amount to about 240,000 tons, representing around two-thirds of the global bismuth reserves.
- The United States Geological Survey reports that the world's total bismuth production in 2022 was approximately 20,000 tons, with China being the largest producer, accounting for about 16,000 tons of the global output. .
- In the short term, the production of bismuth can meet the demand for ZBB Module.

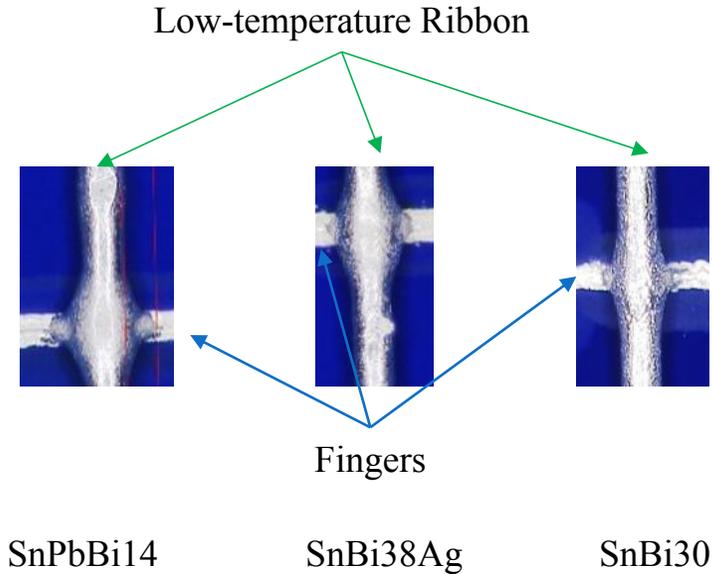
Low-Temperature Ribbon Specification

Technical	Busbar	Ribbon Size mm	Coating Composition	Coating Melting Point	Remark
Regular String	9-20	0.26/0.3/0.32	SnPbBi14	136 ~ 167	Mass production, Mainstream
			SnPbBi21	136 ~ 158	Mass production
			SnBiAg	138 ~ 180	Small demand
ZBB	16-28	0.18/ 0.2 /0.26	SnPbBi(14-37)	93 ~ 167	Mass production
			SnBiAg	136 ~ 180	Test verification

Physical Properties

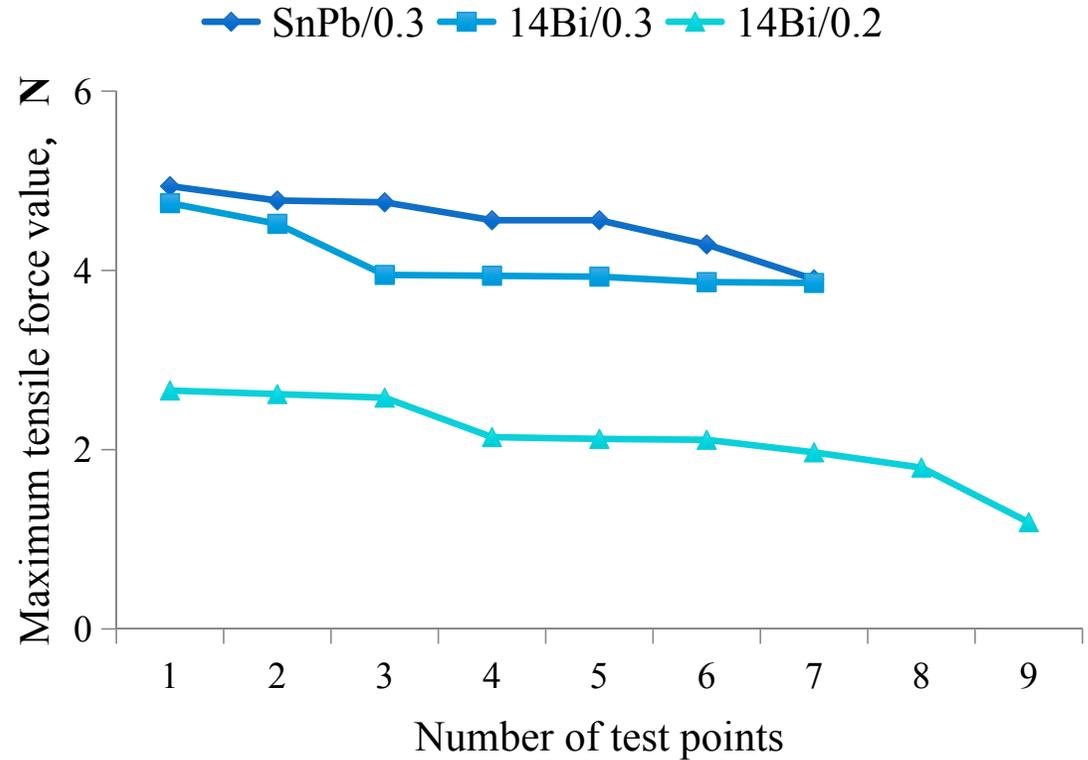
Ribbon Size (mm)	0.3	0.26	0.2
Average Coating Thickness (μm)	17±5	15/13/10±3	10±3
Yield Strength (MPa)	≤70	≤75	≤90
Tensile Strength (MPa)	≥150	≥150	≥150
Elongation (%)	≥20	≥20	≥20

Wettability and Tensile Strength



Solder Temperature 200-220°C

Ribbon Diameter ø0.2mm



Wettability under the same conditions :
 SnPbBi14 > SnBi38Ag > SnBi30



The soldering experiments using various ribbons and the standard busbar (Sn60Pb40) indicate that the variation in solder composition has a minimal impact on the results. However, it was observed that as the diameter decreases, the resulting tensile strength of the solder joint tends to be lower.

Corrosion Resistance



The standard electrode potentials for Sn, Pb, and Bi are -0.136V , -0.126V , and 0.317V , respectively. A larger potential difference between these metals indicates a faster rate of **electrochemical corrosion**.



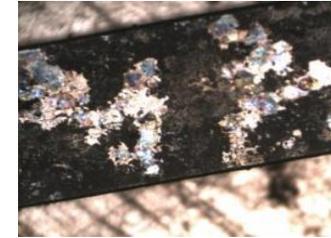
The addition of elements like P, Ga, Ge, Ni, or rare earths can enrich the surface of low-temperature solder tape or refine its grain structure, thus reducing corrosion. However, even with these additions, there is still a notable difference in corrosion resistance compared to Sn-Pb solder.



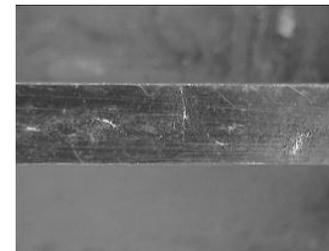
Low-temperature ribbon typically has a significantly shorter shelf life compared to conventional.



SnBi30
Before test



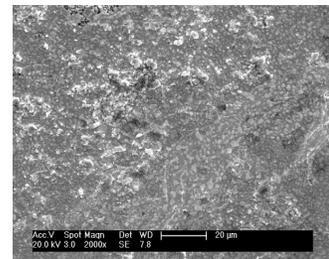
After 36h salt spray test,
50X



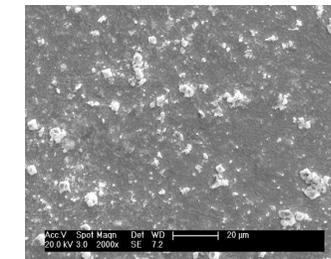
Sn60Pb40
Before test



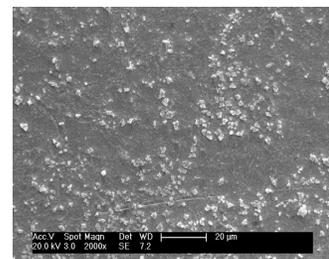
After 36h salt spray test,
50X



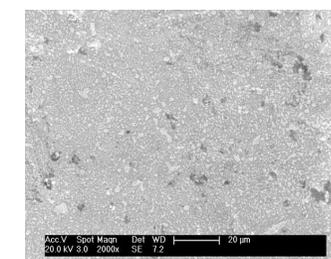
SnBi30 ,
After 36h
spray test



SnBi30 ,
250ppmGe
After 36h salt spray
test

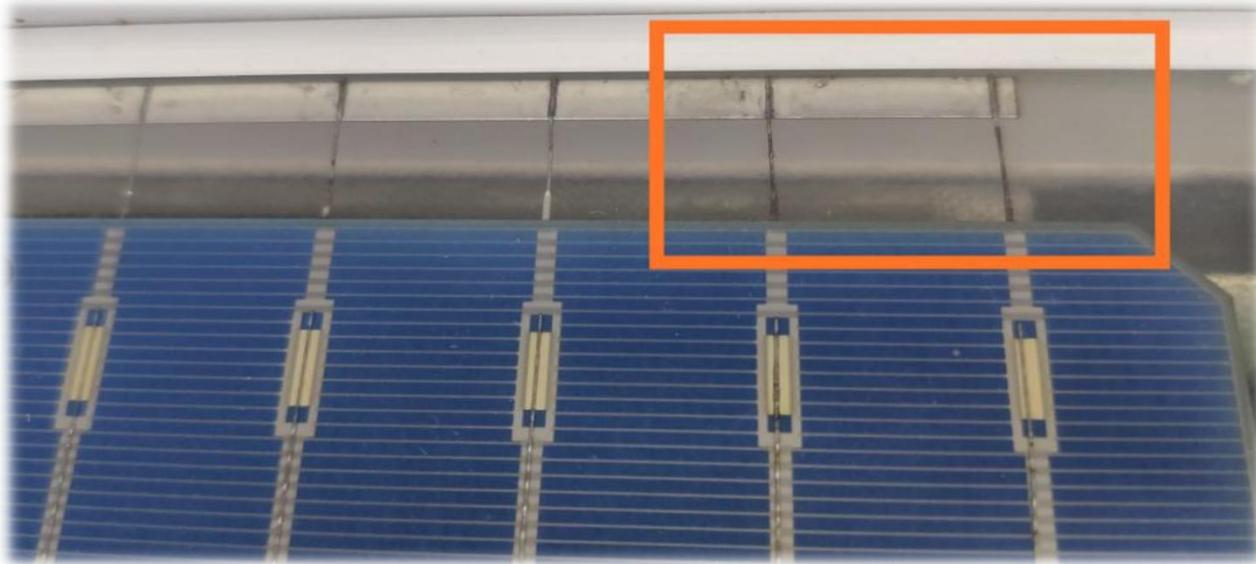


SnBi30 ,
500ppmGe
After 36h
spray test



Sn60Pb40
After 36h salt
spray test

Reliability comparison



1 After the DH1000 processing, the ribbon may turn yellow; following lamination, it can exhibit a greenish tint; and after TC200 processing, some areas of the ribbon may darken. These color changes could be influenced by various factors, including moisture permeation through the backsheet, acidity of the EVA material, and residual flux from the soldering process.

- 2**
- ❑ Double Glass is more suitable than single.
 - ❑ The higher the content of bismuth in the solder, the worse the reliability performance.
 - ❑ Due to the brittleness of bismuth, the higher the bismuth content, the greater the potential attenuation after TC.



Solder composition	PCT48		DH1000		DH2000	
	Single Glass	Double Glass	Single Glass	Double Glass	Single Glass	Double Glass
SnPbBi10	OK	OK	OK	OK	Slight yellow	OK
SnPbBi21	OK	OK	yellow	OK	Obvious yellow	OK
SnBi38Ag	OK	OK	Yellow, blue and purple	OK	Yellow, blue and purple	OK
Sn60Pb40	OK	OK	OK	OK	OK	OK

Ultra-Thin and Ultra-Narrow Flat Welding Ribbon xBC Application

- ❑ In xBC solar panels, where both the positive and negative terminals of the cells are located on the backside, the currently used interconnection method involves a flat welding wire with dimensions of 0.25 mm by 0.6 mm.
- ❑ In 2024, the anticipated production capacity for xBC solar panels is as follows: Longi is expected to release 70GW, Aixu 35GW, and Jinko 10GW. The total expected output is projected to surpass 50GW.
- ❑ In the future, the trend might be towards even narrower and thinner welding wire, but there is also a possibility of shifting to the use of ultra-fine round welding wire.



Ultra-Thin and Ultra-Narrow Flat Welding Ribbon

Size(Thickness mm*Width mm)	0.25*0.6	0.2*0.6/0.4	0.1*0.4/0.3
Coating (Average) (um)	18~25	15~23	10~13
Yield Strength (Mpa)	60-75	65-80	80-90
Elongation (%)	≥25%	≥25%	≥25%
Tensile Strength (Mpa)	≥150	≥150	≥150
gram weight per meter (g/m)	1.215~1.33 2	0.810~0.855	
Resistivity (mΩ/m)	133~144	200~220	

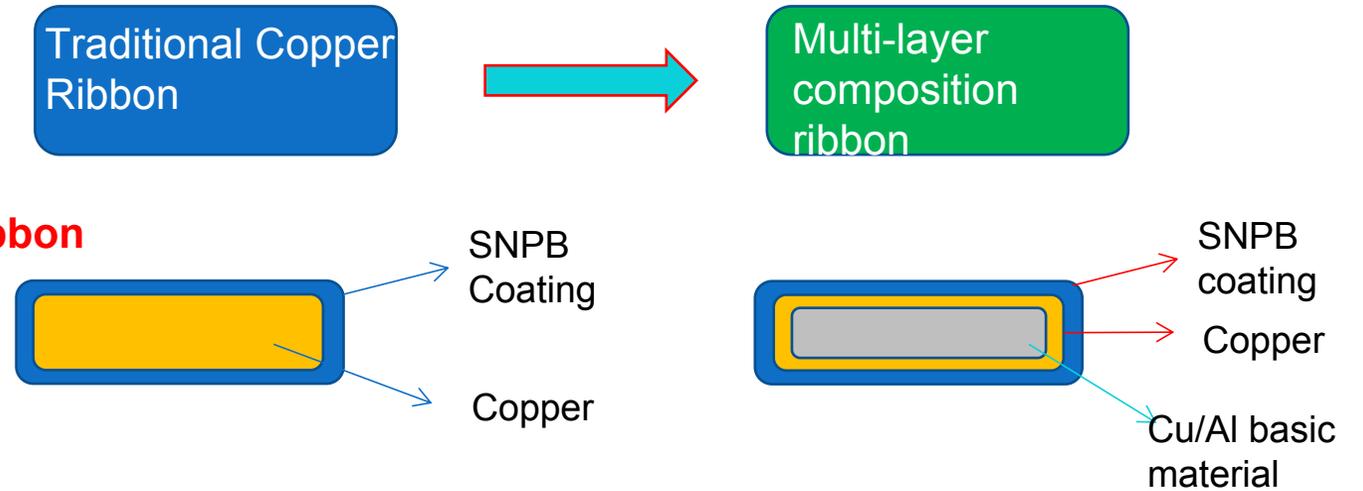
Advantages

- Low yield strength
- Even Coating Thickness
- Excellent weldability

★ The technology pathway for cost reduction: Multilayer composite ribbon

Ribbon Type :

- ❑ Multi-layer Composite Flat Ribbon
- ❑ Multi-layer Composite Collecting Ribbon
- ❑ Multi-layer Composite Reflective Collecting Ribbon
- ❑ Composition : Cu50%AL50%、 Cu40%AL60%、 Cu30%AL70%、 Cu20%AL80%



Application :

1. Multi-layer Composite Flat Ribbon

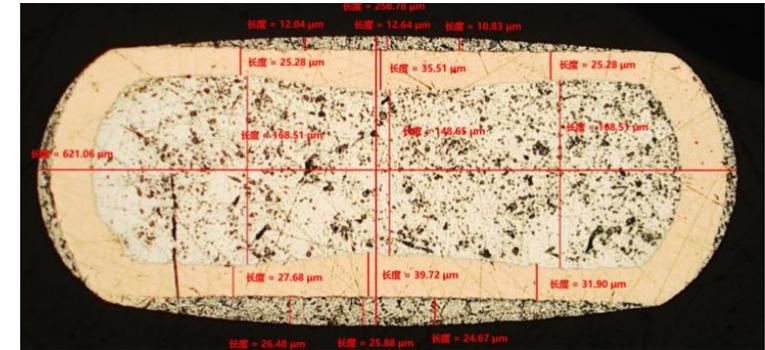
In the application of BC technology, the increased number of main busbars and the use of a larger cross-sectional area significantly reduce the current carrying capacity required for a single welding tape. For cost minimization purposes, multi-layer composite flat welding tape can replace traditional copper-based flat welding tape, substantially cutting the cost of materials for series connecting wires.

2. Multi-layer Composite Busbar

This can be utilized to substitute the busbars at the beginning and end sections of component terminations. However, the central busbars cannot be fully replaced due to challenges related to bending.

Datasheet-Multi-layer Composite Ribbon

xBC Ribbon		
Size (Thickness mm*Width mm)	0.25*0.6	0.25*0.6 (多层复合 Cu60Al40)
Thickness (Average) (um)	18~25	18~25
Yield Strength(Mpa)	60-75	60-75
Elongation (%)	≥20%	≥18%
Tensile Strength (Mpa)	≥150	≥110
Millicoulomb weight(g/m)	1.215~1.332	0.67~0.8
Milliohm (mΩ/m)	133~144	175-190



Advantages:
 The average millicoulomb weight decreases by approximately 45%.
 The BOM usage of components decreases by 45% year-on-year.
 The cost of ribbon decreases by about 0.02 yuan/W.

Disadvantages:
 Milliohm resistance increases by approximately 30%.
 Module power decreases by about 1.8~2.2W.

Reliability Testing for Multi-layer Composite Ribbon

Reliability Testing
Salt Spray Testing
Corrosion resistance test of bare ribbon for 48 hours

Test duration: 48 hours

Result evaluation: RP/RA = 10/9 vs A

PCT Testing
Accelerated aging performance test for 196 hours (double glass)

Test duration: 196 hours

Result evaluation: no obvious yellowing and color difference

YourBuddy... 宇邦

第 1 页, 共 2 页

苏州宇邦新型材料股份有限公司检测中心

检验检测报告

编号: T2024-00072

产品名称	高阻焊带	规格型号	0.25*0.6
委托单位名称/地址	苏州质量部/苏州市吴中区越溪路 688 号		
生产单位	生产部		
检测样品数量	1 件	生产日期/批号	2024.11.15/—
样品接收日期	2024.11.15	检验检测日期	2024.11.20-2024.11.28
检测依据	GB/T 6461-2002 《金属基体上金属和其他无机覆盖层经腐蚀试验后的试样和试件的评级》; GB/T 10125-2021 《人造气氛腐蚀性试验 盐雾试验》; T/CPIA 0005-2022 《光伏涂锡焊带》		
序号	检验项目	单位	实测值
1	耐腐蚀性能 (48h)	---	---
1.1	外观评级 (R _a)	---	出现少量的浅灰色斑点, 外观缺陷面积为 0.1%, 外观评级为 9 级
	保护评级 (R _p)	---	基板未出现腐蚀, 保护评级为 10 级
	性能评级 (R _p /R _a)	---	10/9 vs A
2	PCT 加速老化性能 (192h)	---	试验后, 距焊带两侧 10 mm 起色泽无明显黄变及发黑

盐雾试验前图片

盐雾试验后图片

实验室地址: 苏州吴中区越溪路 688 号/215100; 实验室服务电话: 0512-65690690; 实验室传真: 0512-65691913; 实验室 E-mail: zhujiaofeng@yourbest.com.cn; 实验室网址: www.yourbest.com.cn. JL7.8-01/A0

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PCT 试验前图片

PCT 试验后图片

检验结论: 提供实测数据。

签发日期: 2024年11月20日

备注:

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- 送检样品及客户信息均由客户提供, 本机构不对其正确性负责;
- 本报告 PCT 加速老化性能依据 T/CPIA 0005-2022 中条款 7.10 进行试验, 但试验时间为 192h;
- T/CPIA 0005-2022 中条款 6.8 规定, 焊带经 48 h 的中性盐雾试验后, 按 GB/T 6461 的规定进行评级, 保护评级 (R_p) 应为 10 级; 外观评级 (R_a) 中, 焊带表面的斑点和局部的颜色变化 (发暗) 的总缺陷面积应不低于 4 级且表面不应出现发黄、发黑、起皮、剥落、鼓泡、开裂、龟裂现象。

批准:

实验室地址: 苏州吴中区越溪路 688 号/215100; 实验室服务电话: 0512-65690690; 实验室传真: 0512-65691913; 实验室 E-mail: zhujiaofeng@yourbest.com.cn; 实验室网址: www.yourbest.com.cn. JL7.8-01/A0

Classification



1. Double-sided tin-plated all-black busbar (single-sided with thin coating)
2. Single-sided tin-coated all-black busbar
3. Punched segmented black busbar
4. Irregular fixed length punched black busbar

Advantages

1. Excellent black appearance (color can be adjusted according to customer needs)
2. Black coating has high adhesion, high ductility and high temperature resistance
3. Excellent aging performance makes the black component warranty 25 years without pressure

序号 SN	可靠性试验项目 Reliability test items	试验结果 Test result	试验单位
1	UV200kWh/m ²	OK	A
2	QUV1000h	OK	A
3	DH1250h	OK	A
4	HF20	OK	A
5	HAST96h	OK	A
6	DH2000h	OK	H
7	TC400	OK	H
8	常规IEC Regular IEC	OK	L

Black Busbar

项目 Test items	性能参数 Performance parameters
黑色焊带规格 Black busbar specification	可定制 Customized
铜基材规格 Copper specification	可定制 Customized
尺寸 Size	厚度: -0.01 ~ +0.03mm ; 宽度: ±0.1mm Thickness: -0.01 ~ +0.03mm ; Width: ±0.1mm
焊料成分 Solder Composition	Sn60Pb40 or Sn63Pb37
外观 Appearance	焊接面: 光滑、平整、允许有不影响焊接的黑色颗粒层 Welding surface: smooth, flat, black particle layer is allowed without affecting welding
	黑色面: 平整, 无划伤、皱皮、露底 Black surface: smooth, no scratches, wrinkles, or exposed bottom
锡层厚度 Solder Thickness	20±5μm
黑色涂层厚度 Black coating thickness	18±5μm
黑色涂层附着力 Black coating adhesion	经划格试验, 黑色材料脱落面积不超过5%
耐高温性能 High temperature resistance	将黑色焊带的常规面在380℃下进行点焊, 5s后, 黑色涂层不脱落
抗拉强度 Tensile strength	≥170MPa
延伸率 Enlongation	≥25%

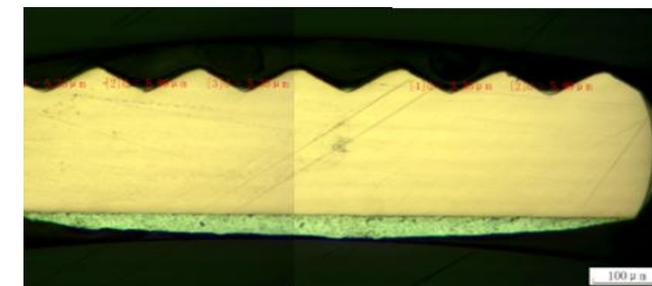
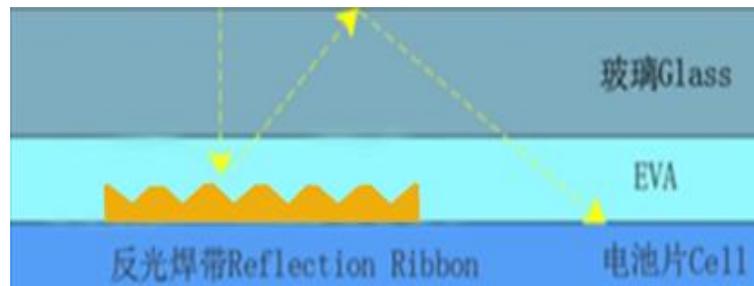
注意事项 Precautions

- 1、点焊温度尽量不要超过380℃ ;
 - 2、点焊之后, 在焊点完全凝固之前, 保证焊带不要移动, 否则容易引起黑色涂层脱落。
1. The spot welding temperature should not exceed 380℃ as far as possible; 2. After spot welding, before the solder joint is completely solidified, ensure that the solder strip does not move, otherwise it will easily cause the black coating to fall off.

Reflective Busbar

Theory

Reflective welding tape features a uniquely textured surface that redirects sunlight reflected from the tape back onto the solar cells. Unlike standard welding tape, which reflects most of the light back into the air, this reflective tape maximizes light capture. By increasing the amount of light incident on the solar cells over time, it boosts the overall power efficiency of the solar module.



Our Advantages

- ❑ Utilizing an advanced calendaring technique, the groove's top edge is honed to a sharpness of less than 20 micrometers, optimizing the surface for maximum light reflection.
- ❑ With precise control over the coating thickness, the tin layer within the groove is maintained at a thickness of 10 micrometers or less.
- ❑ The textured surface exhibits exceptional smoothness and is free from any damage, ensuring optimal performance.

Application Type

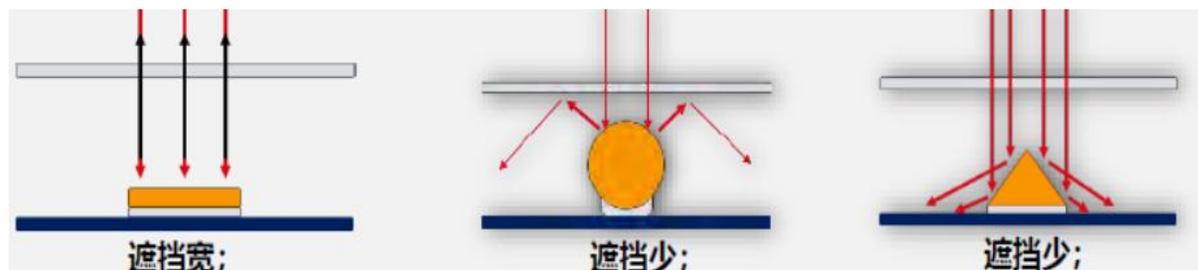
When using a 5-series module jumper, a power gain of 1.5~2W can be achieved (based on a comparison with a 450W module).

By replacing the conventional busbars with the head, middle, and tail sections of a standard module, a power gain of 0.8~1W can be achieved (based on a 550W module comparison). This represents a power gain of 0.18%. 25

Reflective Busbar	Size 1	Size 2	Size 3	Size 4
Size(Thickness*Widthmm)	0.25*3~8	0.3*3~8	0.35*3~8	0.4*3~8
Coating Thickness- Reflective side (um)		10±5 or ≤10		
Coating Thickness -Welding Side (um)		30±5		
Yield Strength (Mpa)		≤110		
Remark : Customized				

Ultra-thin High Reflectivity Welding Tape

What structure exhibits the highest optical efficiency?



Based on the inferred current gain from solar cells, the high-reflectivity welding tape is evaluated against a circular welding tape with matching resistance and shading width (noted for manual testing with considerable variability).

- TOPCon solar cells, the power gain is approximately 5W.
- For HJT solar cells, the power gain exceeds 7W.

Advantages

- ❑ Minimizing interconnect shading (approximately 2% of the total area)
- ❑ The triangular design allows for a single reflection, maximizing optical efficiency.
- ❑ The flat back configuration effectively reduces the risk of hidden cracks and decreases the weight of the encapsulant material.

What technical reserves have we made?

Segmented Designs: Triangle with Flat Surface, Triangle with Round Surface (for higher double-sided efficiency)
 Continuous Design: Triangle

CORE ADVANTAGES

1 R&D Advantages

2 Production Capacity

3 Quality Assurance

R&D advantages - leading technological achievements in the industry

R&D System

Advanced R&D Center

YOURBEST has established a research and development center with complete departments and is equipped with industry-leading research and development equipment and testing instruments for conducting research and development of PV Ribbon.

Mature R&D mechanism

YOURBEST has established a series of research and development management systems related to product design and development, which standardize the process of research and development of PV ribbon technology and process design, and conduct product research and development in a standardized and efficient manner.

Strong R&D team

YOURBEST has a strong research and development team, with core technical personnel possessing rich production technology experience and multiple invention patents. Some core technical personnel are the main drafters of national standards.

Excellent R&D partners

YOURBEST actively collaborates with external universities and institutions, including Southeast University, Shanghai Jiao Tong University, and the University of New South Wales in Australia, to enhance its research and development capabilities.

R&D Achievement



Up to now, the company has **126** valid authorized **patents**, including **34 invention patents**, which is in the leading position in the industry. The number of invention patents for which applications have been accepted up to now far exceeds that of the peers.



Yourbest has **6 core technologies**, all of which have been developed and patented by the company, playing a leading role in improving the production process of the photovoltaic welding strip industry.

CNAS lab qualification

Three consecutive expert committees of the Association's Standards Expert Committee



As of now, the company has multiple projects under development, all of which are related to industry innovation and future development directions.



In the past three years, **the company's R&D expenses have totaled more than 160 million yuan**. In the future, the company will continue to increase investment in the R&D end to consolidate its R&D advantages.

Certificate



Our laboratory - with advanced and complete testing equipment, instruments



CNAS Lab

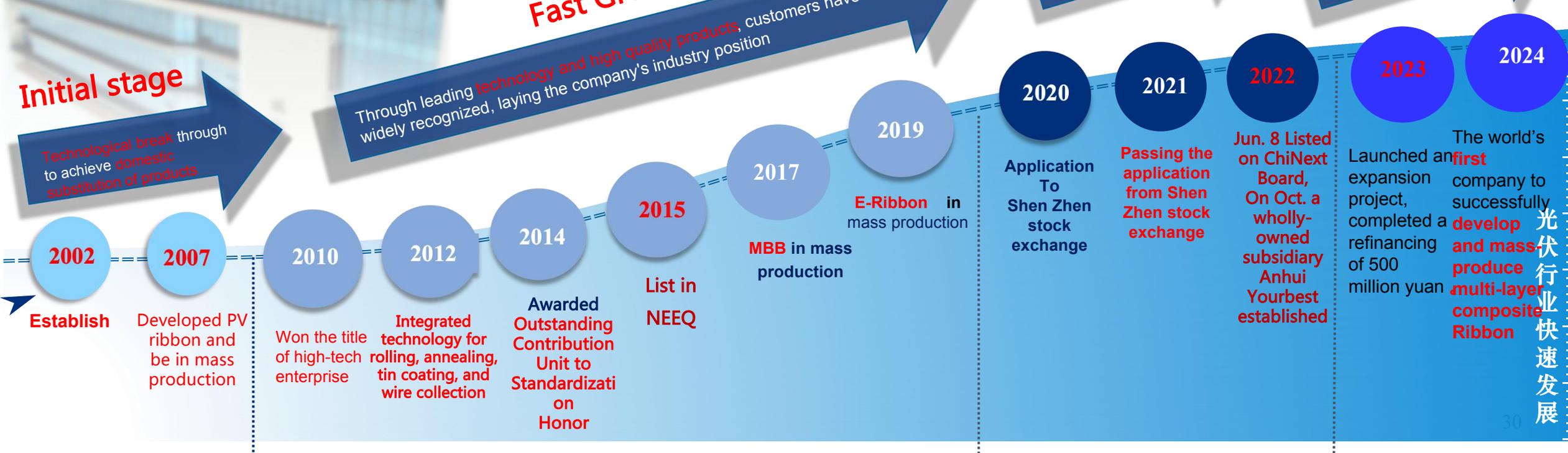


We have the most advanced ribbon raw materials and product testing equipment

Company development history



The company is committed to the research and development, production and sales of Tinned Copper Interconnect Ribbon, after more than a decade of efforts, has developed into one of the benchmark enterprises in China's Tinned Copper Interconnect Ribbon industry, **is one of the most important suppliers of Tinned Copper Interconnect Ribbon products in the country**, in the research and development strength, process technology is in the leading position in the country, has a high market share.



Domestic



Overseas



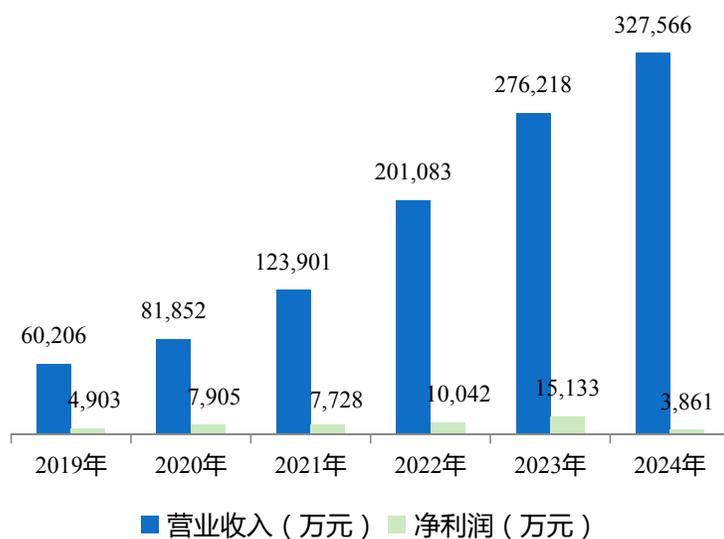
The top 10 photovoltaic module enterprises in China are all company's cooperative customers. The company is headquartered in Suzhou, and its business covers more than 20 provinces and cities in China.

The company actively expands into overseas markets, and its sales areas cover Southeast Asia, Europe, Africa, and South America, among other countries and regions.

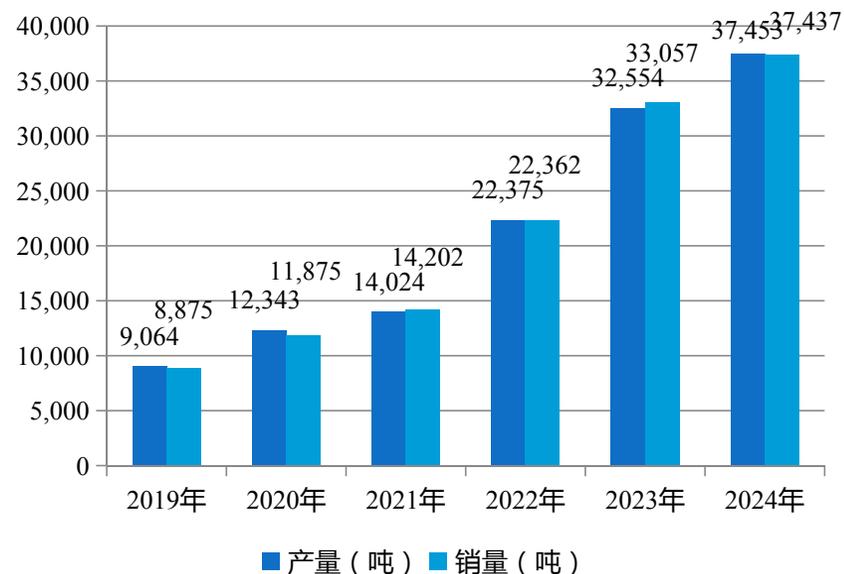
Corporate financial situation

- Thanks to the favorable PV industry boom and the continuous development of comprehensive strength, the company's operating income has continued to increase, and the overall scale and operating conditions have maintained a favorable development trend.

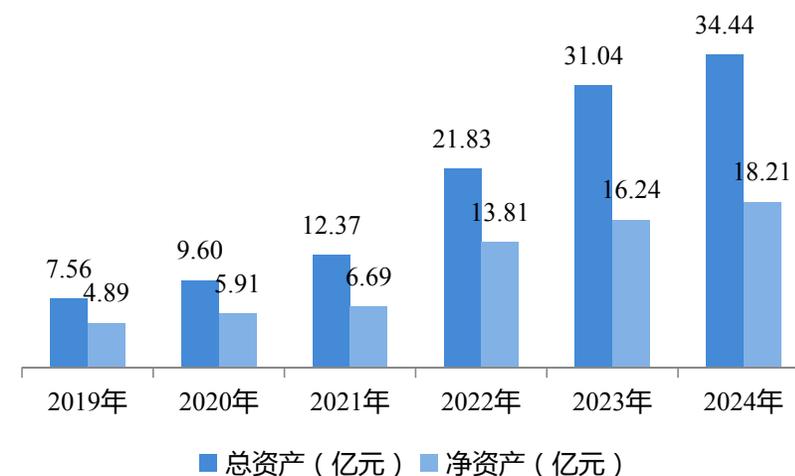
业务规模持续扩增



产销量持续上升



资产规模持续扩增



2025.Jan-Sep.

Operating revenue of 2.26 billion yuan, net profit of 53 million yuan



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