

光伏组件智能装备发展趋势

无锡奥特维科技股份有限公司
董事、副总经理 李文

2023.11



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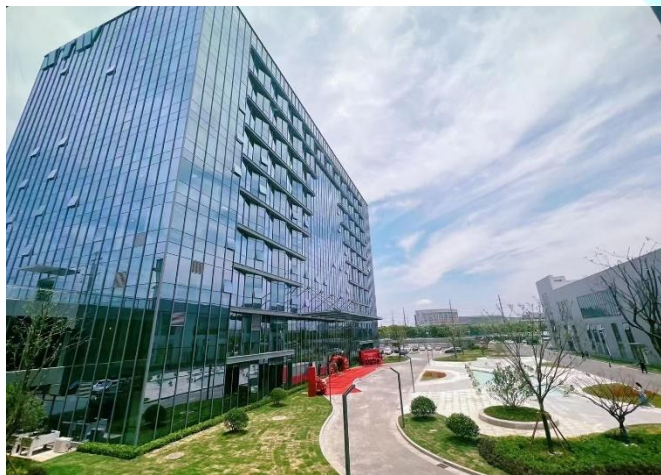


Autowell

We do **automation well**

奥特维

做中国优秀自动化的代表



全世界有工厂的地方 就有奥特维的智能制造系统

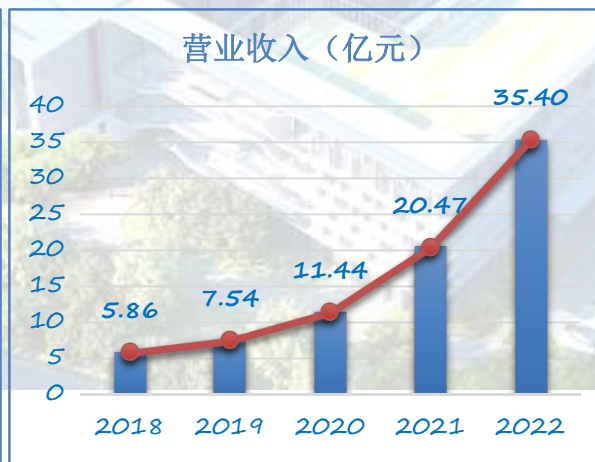


无锡奥特维科技股份有限公司成立于2010年，是国家高新技术企业、江苏省科技小巨人企业，下设三家全资子公司，七家控股子公司，业务横跨光伏、锂电、半导体三个行业，主要从事光伏拉晶/硅片/电池/组件设备、锂电模组/PACK线设备、半导体划片机/装片机/键合机/AOI等高端智能装备的研发、设计、生产和销售，产品远销全球近40个国家和地区，客户生产基地将近600个。

公司现有员工4900多名，其中机械、电气、电子、光学、机器视觉、机器人、计算机等专业研发人员1000多名，拥有完善的从研发到制造、到销售、到服务的端到端的供应链交付体系。

2020年5月登陆科创板，公司业务发展步入快车道。

2022年新签订单突破70亿元，收入超过35亿元，净利润超过7亿元。

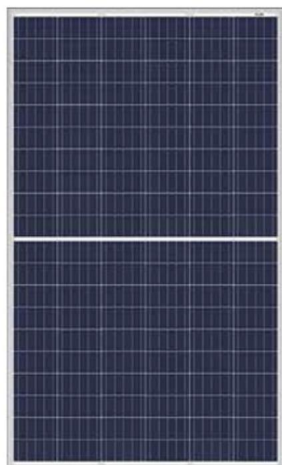
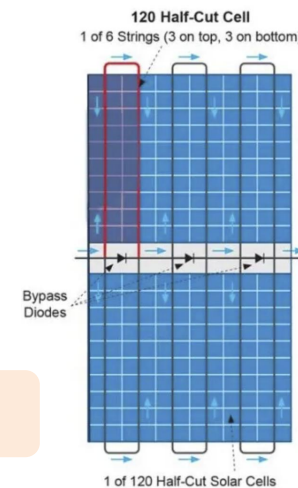
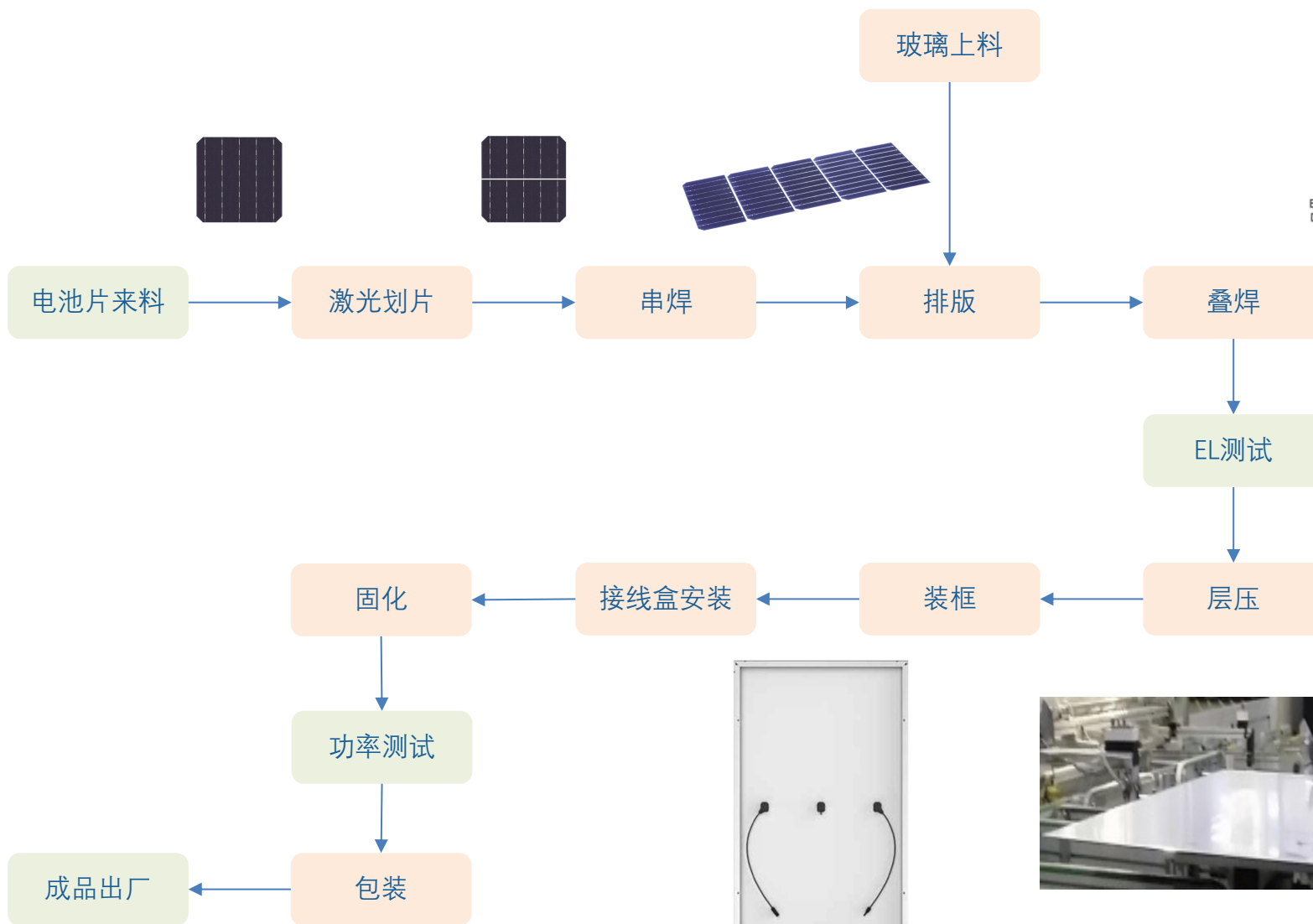
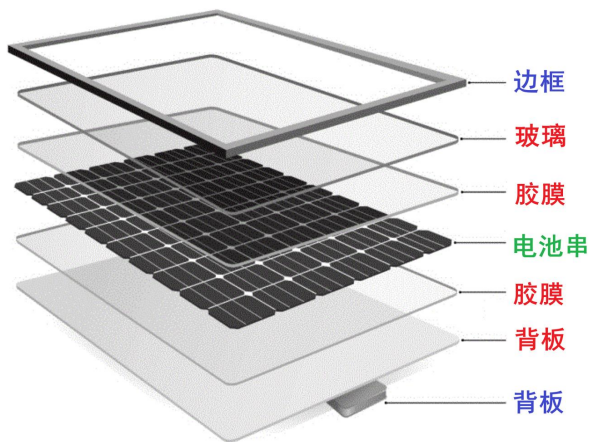


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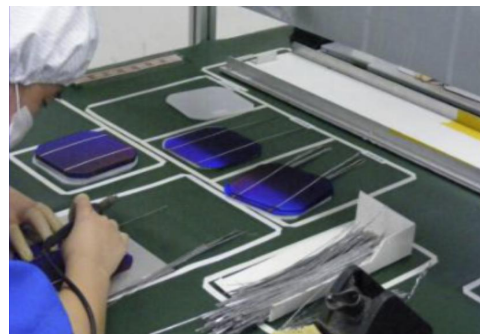
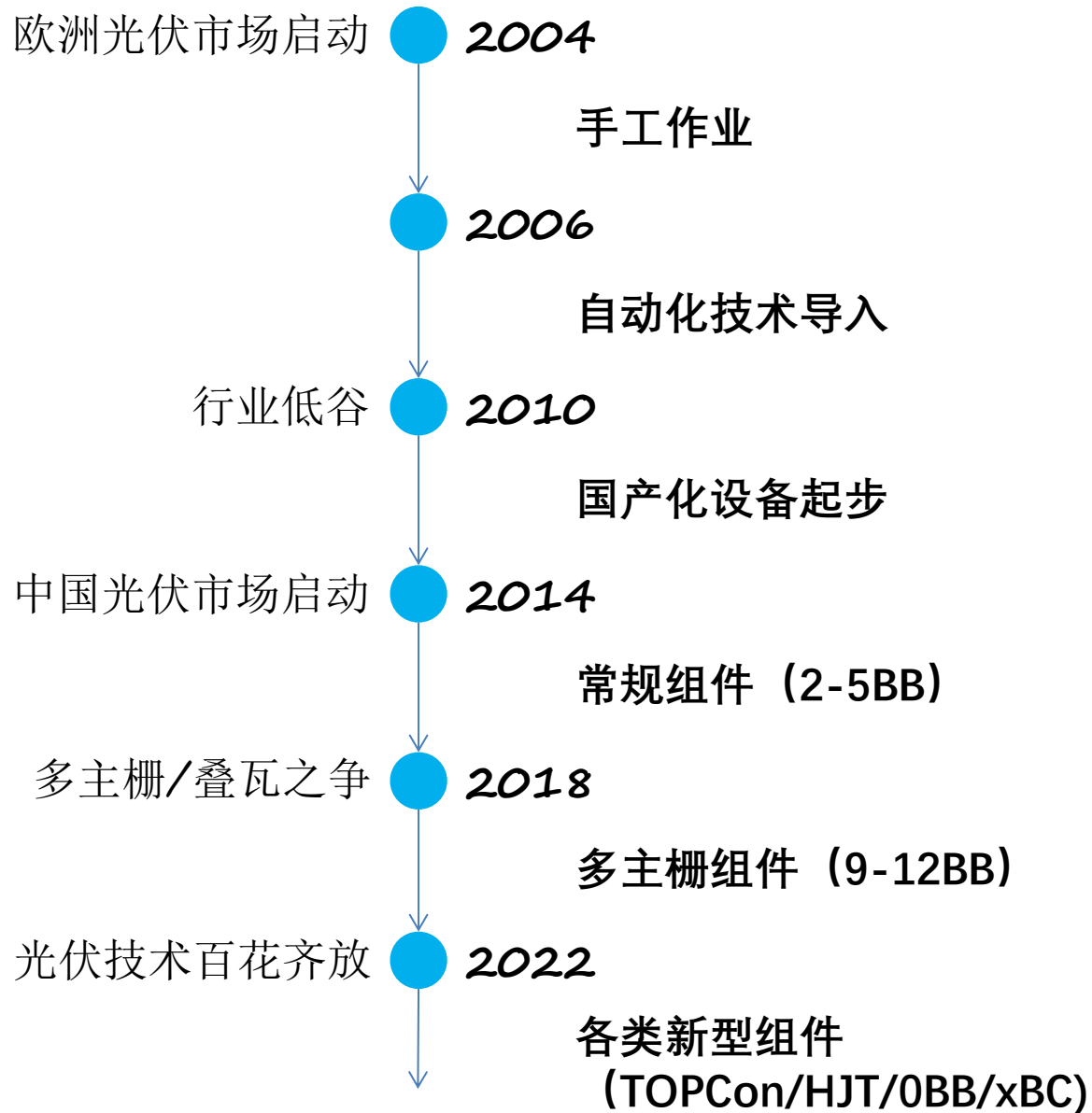
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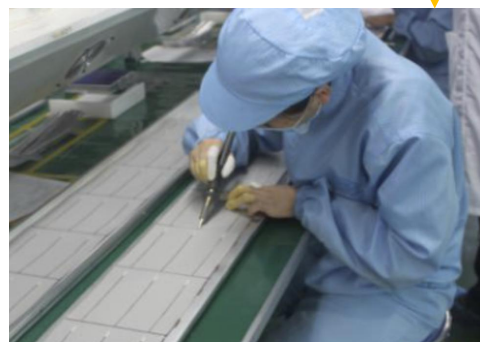
组件装备的发展历程 组件工艺简介



组件装备的发展历程



单焊 (人工)



串焊 (人工)



排版 (人工)



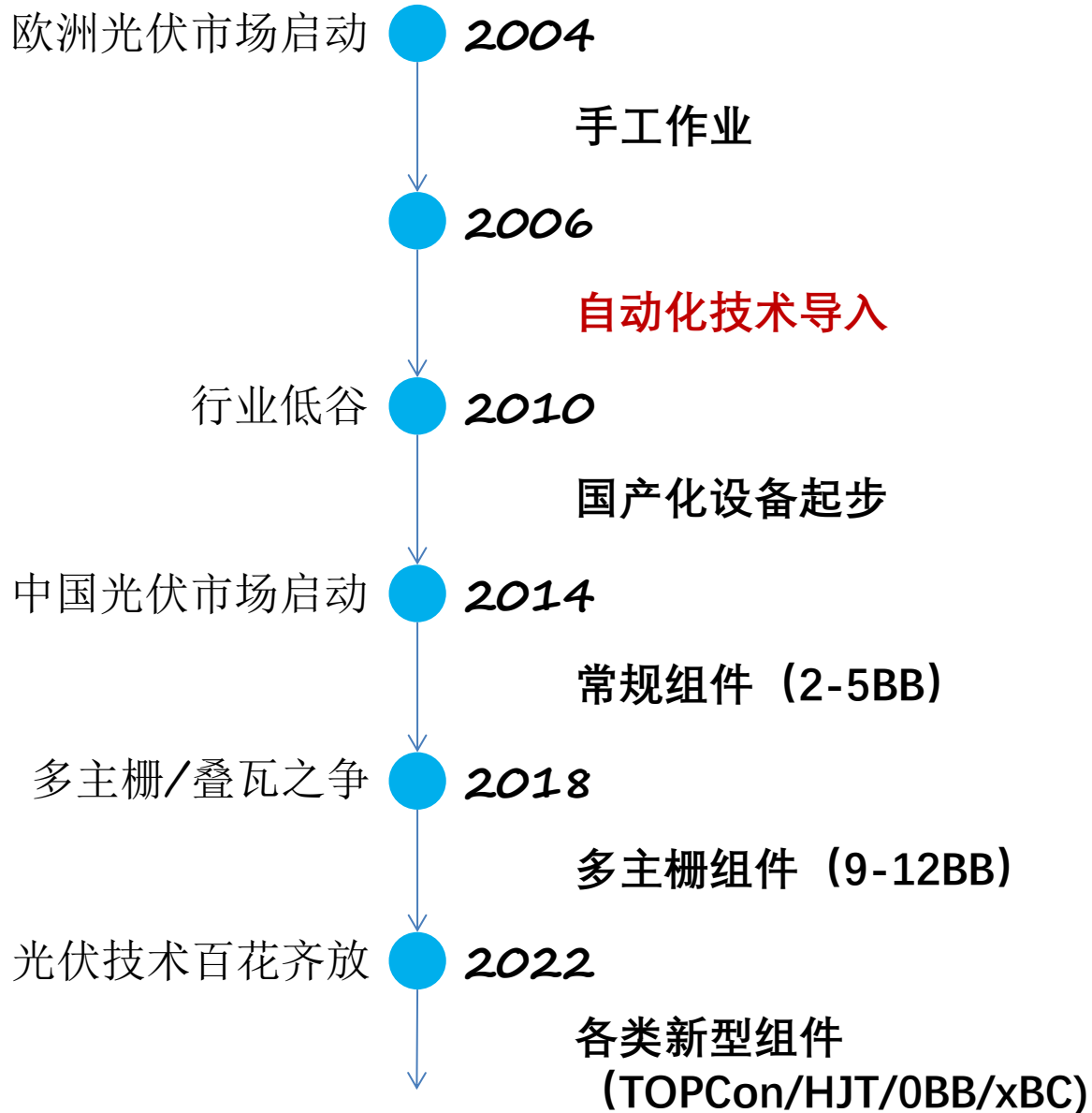
层压 (设备)



接线盒安装 (人工)



检查 (人工)



(Magnetic Induction) Soldering 电磁感应焊接
A soldering head is composed of copper conduction loops that create a magnetic field due to alternating current passing through the coil. Ribbons beneath the loop experience eddy currents as a result of the alternating field which heats the ribbon in a controlled manner. ML soldering is a non-contact method, causing low stress to the cell while enabling very low cycle time

Hot Bar Soldering 热压焊头焊接
A contact method with a low cycle time of about 1.5 seconds per joint, hot bar soldering produces very localized heating. However, thermal cycling performance is not as good as ML soldering limitations may be reached for very thin cells, so further development was discontinued.

Laser Soldering 激光焊接
This is a non-contact method using a laser to produce very controllable and localized heating. Laser soldering heads are expensive and so it was determined that having more than one would not be economically viable, as such the cycle time would be about double that of ML soldering. Due to these economic constraints, development of laser soldering was discontinued.

Flame Soldering 火焰焊接
A mixture of oxygen and acetylene is used to create an approximately 1000 deg C flame, which provides a non-contact soldering method with very localized heating. The soldering cycle time is very low with the flame method, about 0.2 seconds per joint. Although it is the fastest soldering method of those investigated it provided poor reliability results and therefore development of flame soldering was discontinued.

Hot Air Soldering 热风焊接
A non-contact method using hot air to solder the joint, heating is not very localized and leads to cell warping. Cycle time for this soldering method is fairly high at about 5 seconds per joint. Due to the poor performance and low throughput potential of hot air soldering, development was discontinued.

IR Soldering 红外焊接
IR soldering is non-contact, but does not allow for localized heating and as such causes cell warping to the point that cells cannot be laminated. Development of IR soldering was discontinued.






2006 TT推出第一代串焊机



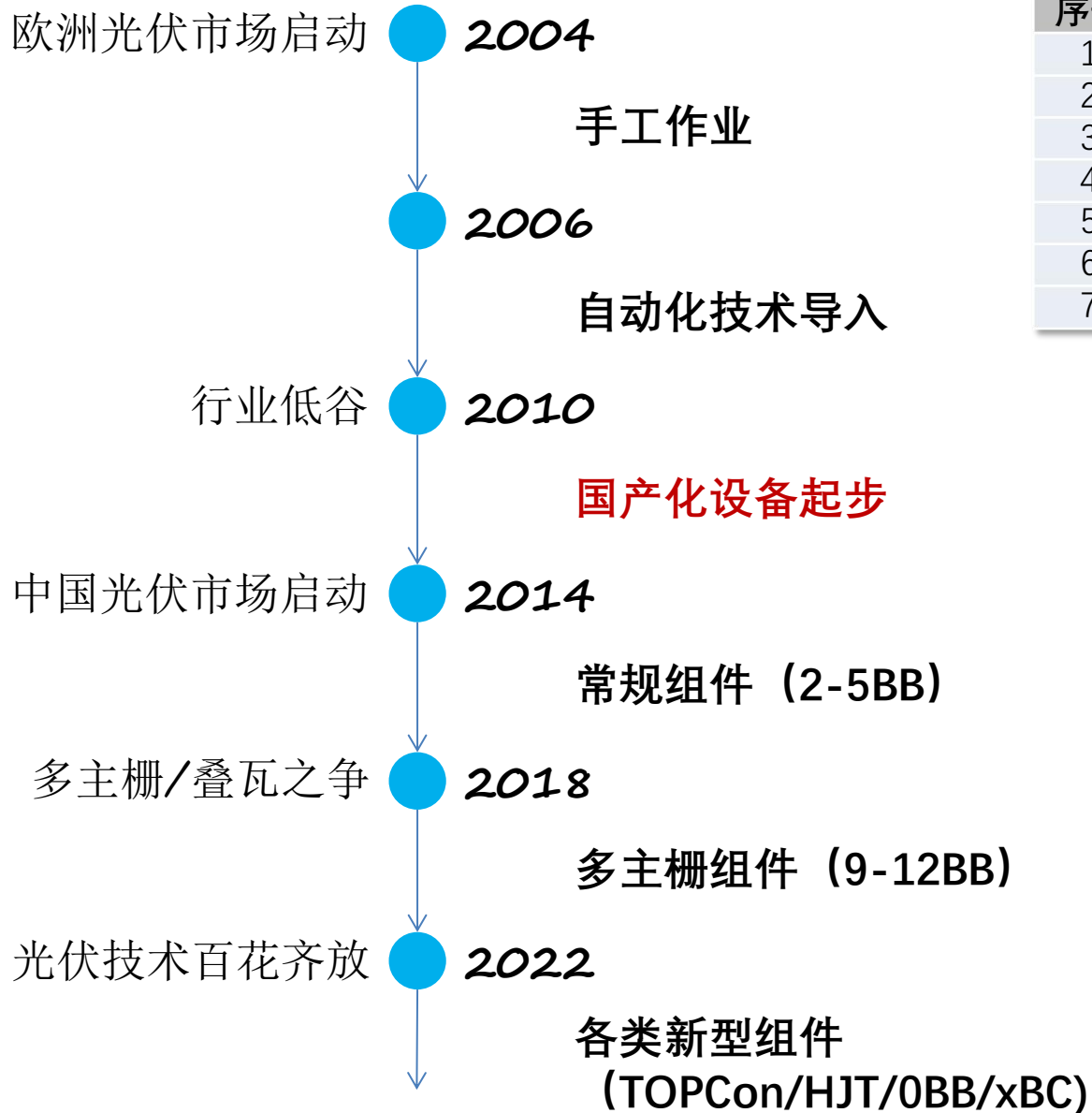
High performance stringer for solar cell strings

Presentation of the first generation of high performance stringers for the production of solar cell strings. Live production of solar strings at major international trade fairs.

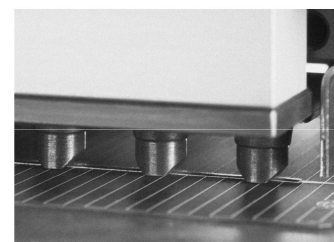
2012年串焊机市场容量

| Rank | Brand | Market Share |
|------|--|--------------|
| 1 |  Komax Holding AG | 20% |
| 2 |  NPC Incorporated | 18% |
| 3 |  teamtechnik Maschinen und Anlagen GmbH | 15% |
| 4 |  Spire Corporation. | 8% |
| 5 |  Gorosabel Solar Energy | 5% |
| 6 |  SOMONT GmbH | 3% |

组件装备的发展历程



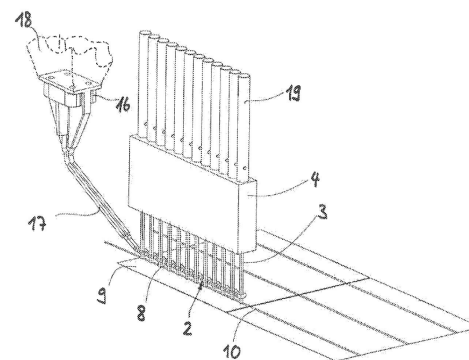
| 序号 | 厂家 | 红外 | 软接触 | 电磁感应 | 热风 |
|----|---------------|----|-----|------|----|
| 1 | 德国Teamtechnik | ■ | | | |
| 2 | 西班牙Gorosabel | ■ | | | |
| 3 | 西班牙Mondragon | ■ | | | |
| 4 | 美国Spire | ■ | | | |
| 5 | 德国Somont | | ■ | | |
| 6 | 美国Komax | | | ■ | |
| 7 | 日本NPC | | | | ■ |



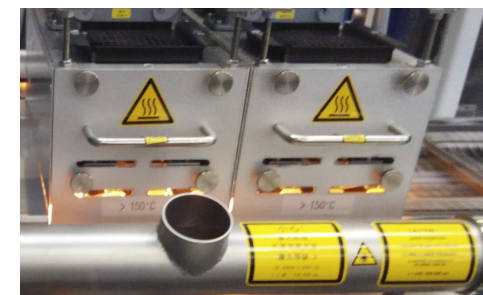
软接触



热风

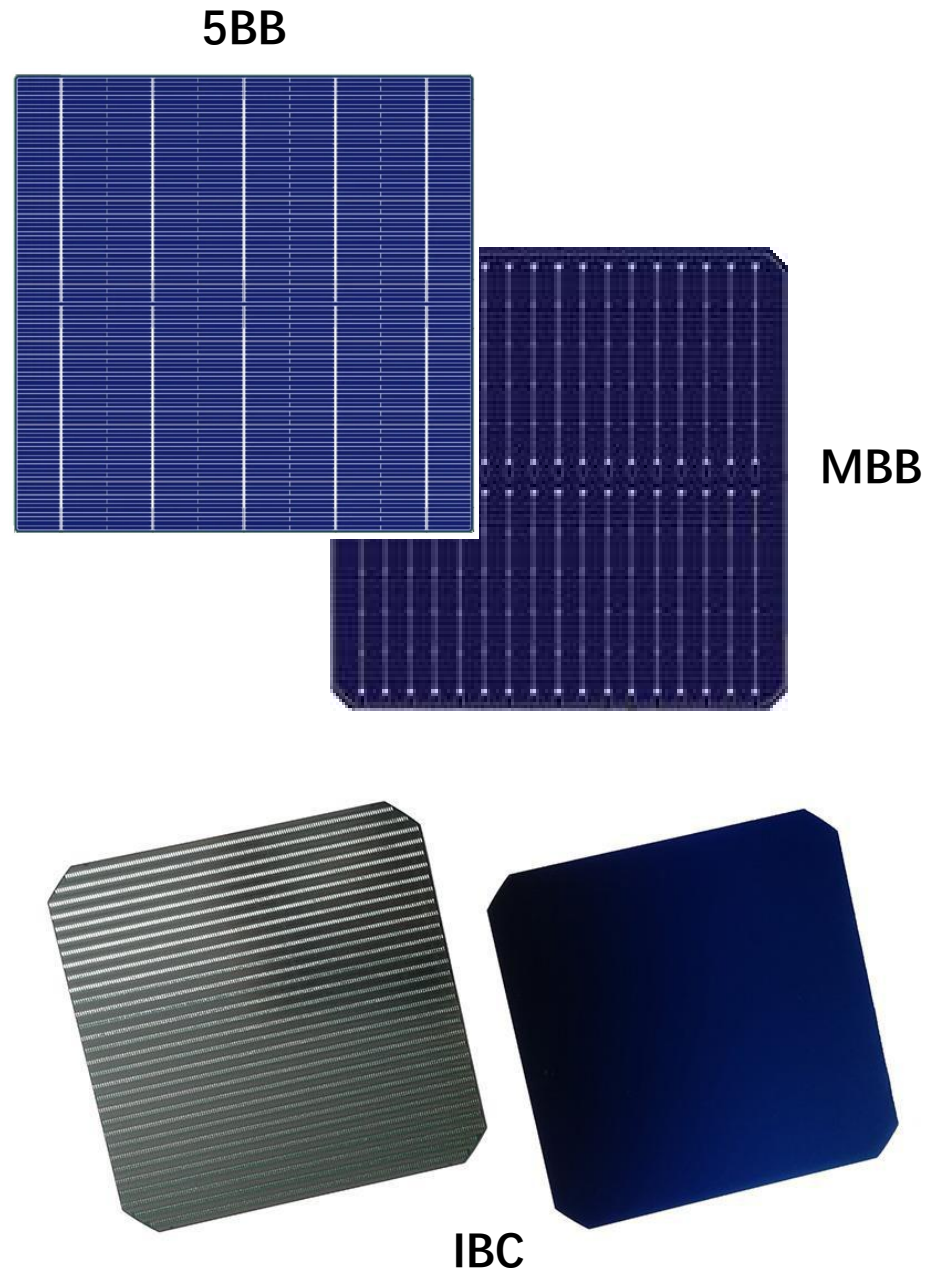
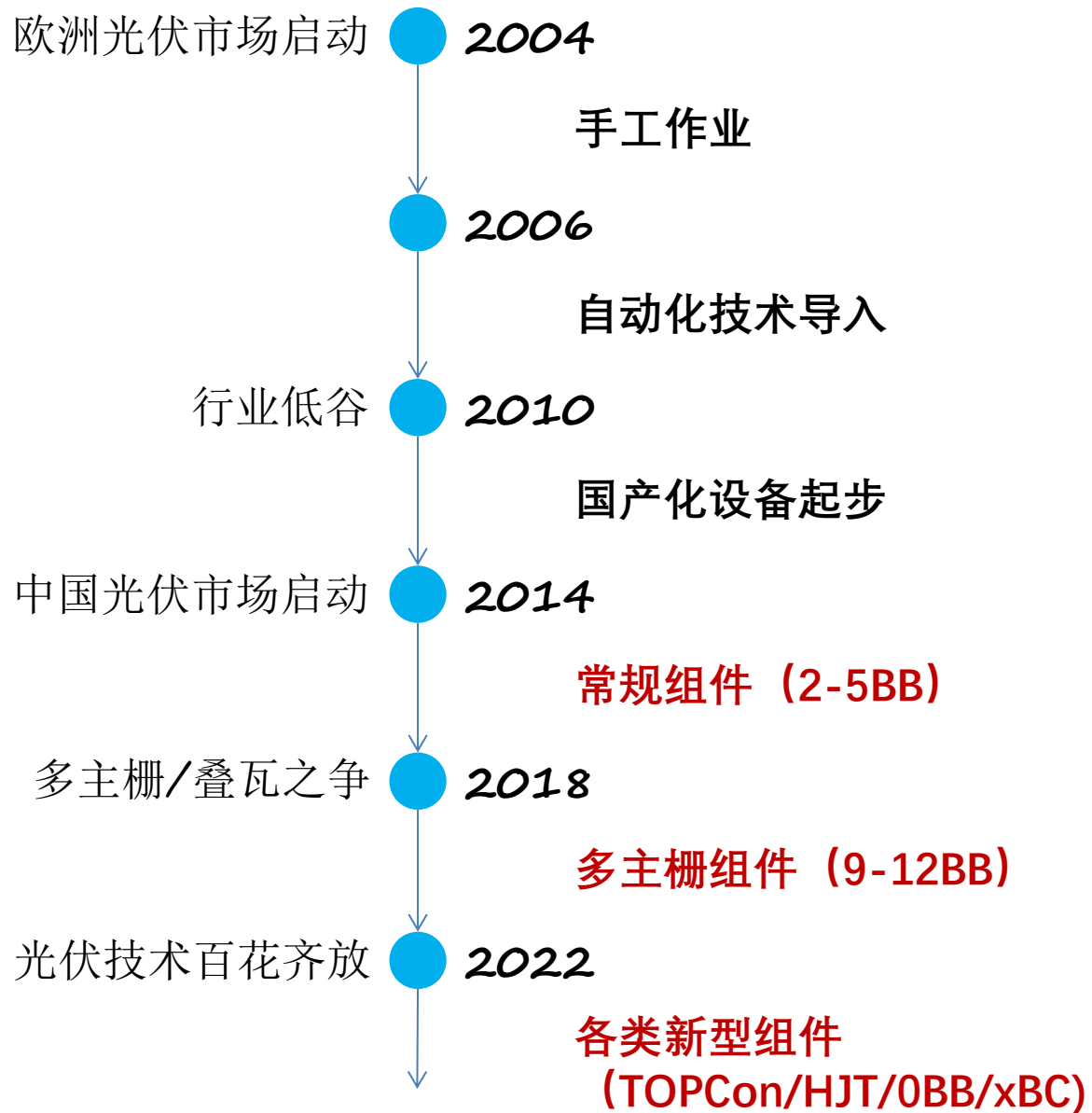


电磁感应



红外

组件装备的发展历程

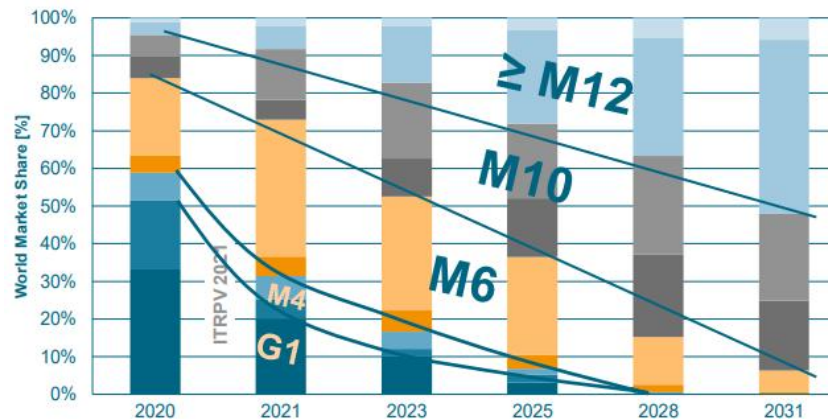
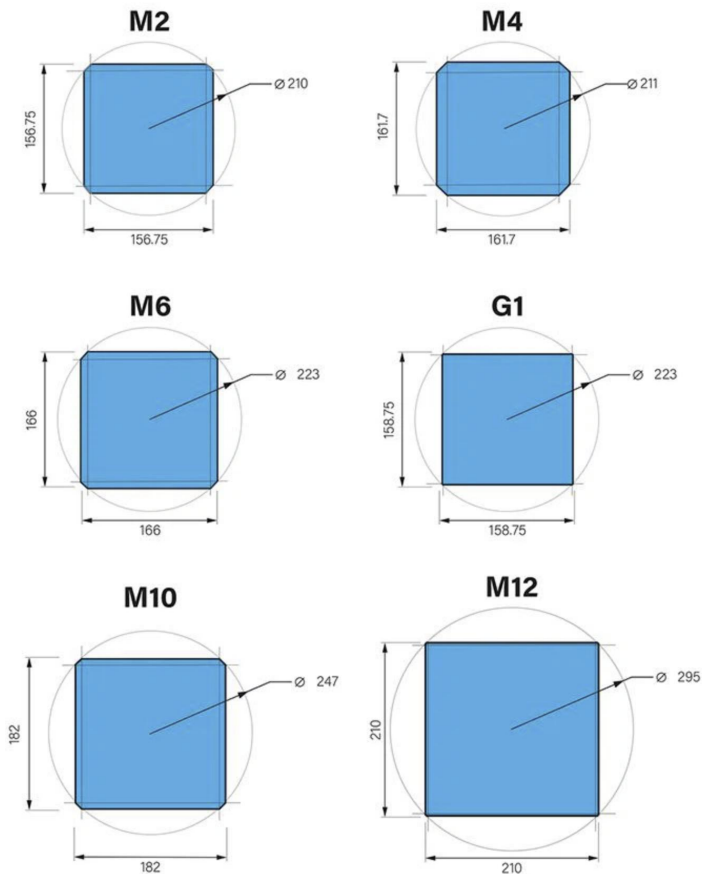


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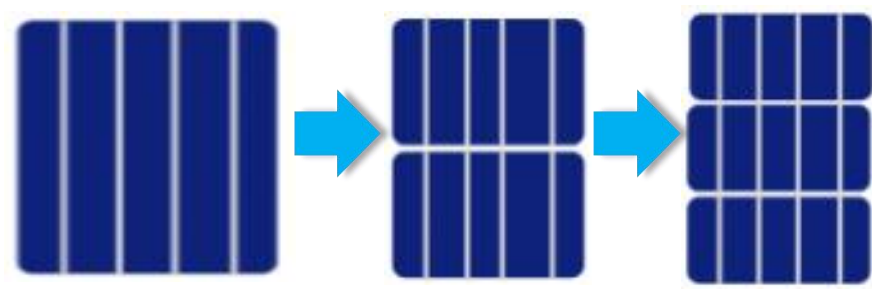
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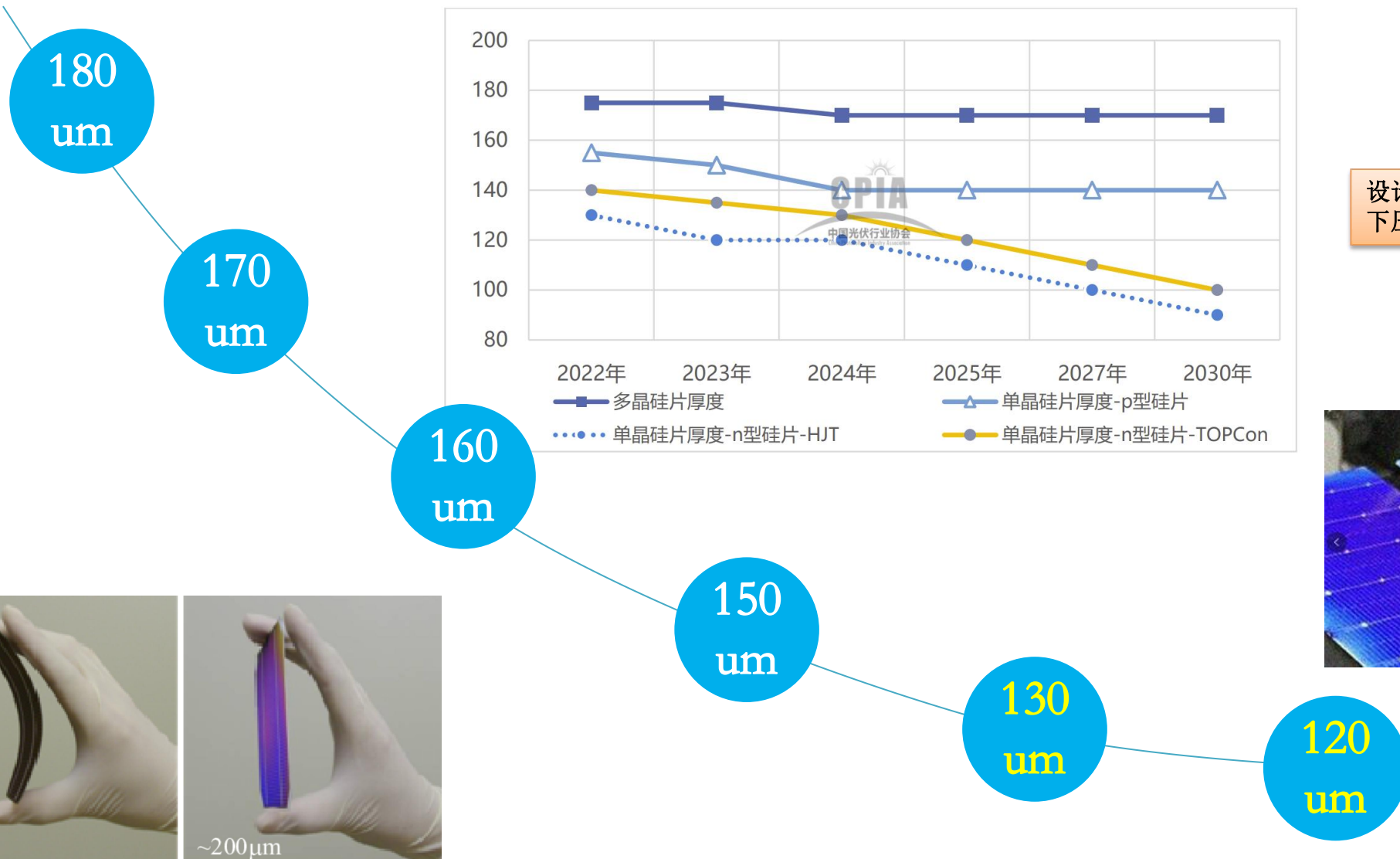
组件工艺的影响因素 电池尺寸



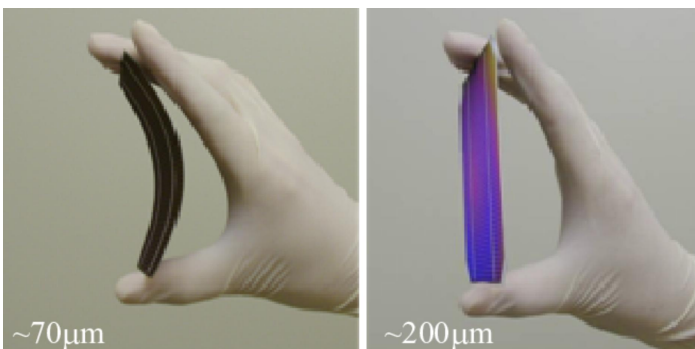
1. 机构不断升级，以适应更大尺寸的电池片；
2. 半分片及多分片组件的出现，要求串焊机速度越来越快。

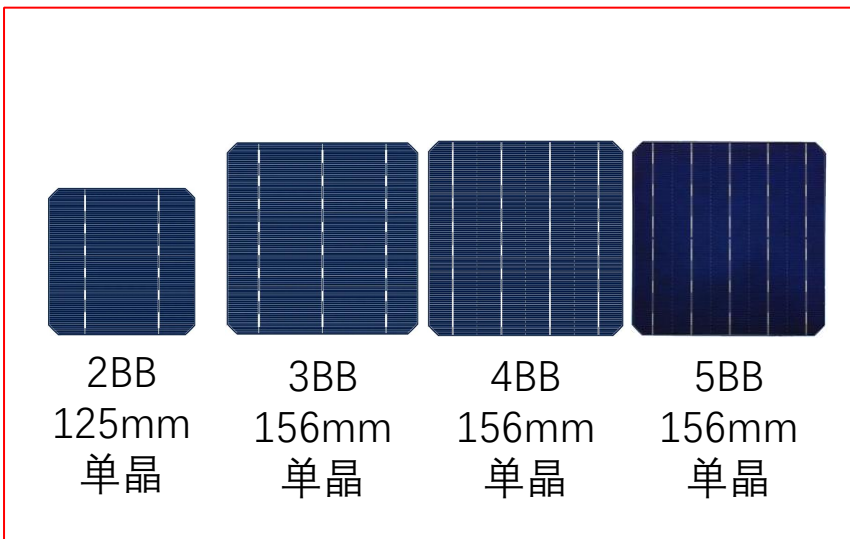
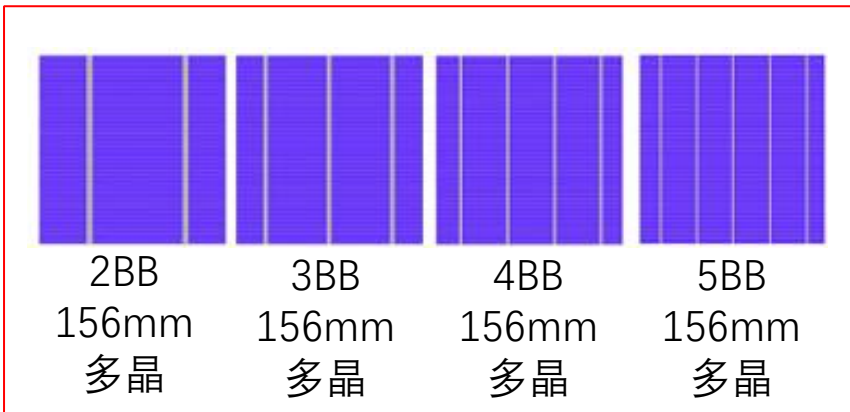


组件工艺的影响因素 电池厚度

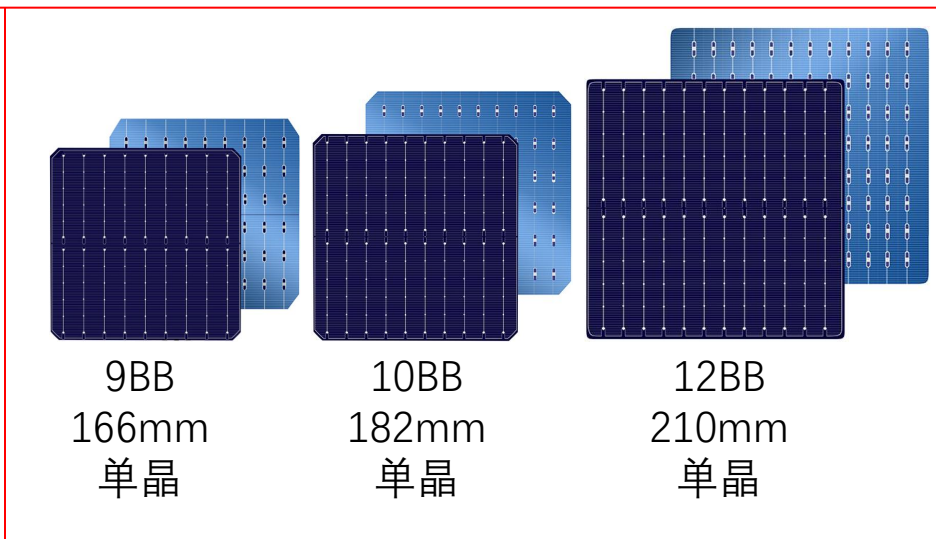


设计更轻柔的抓取、搬运、下压机构，减少薄片碎片率。

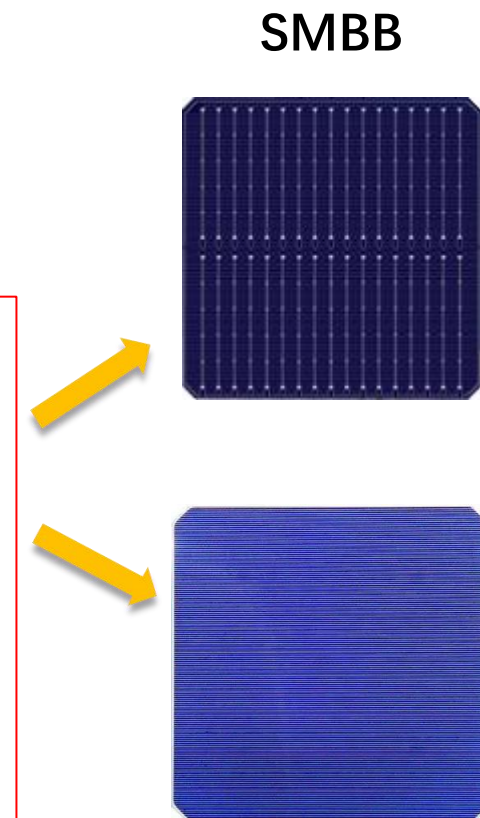


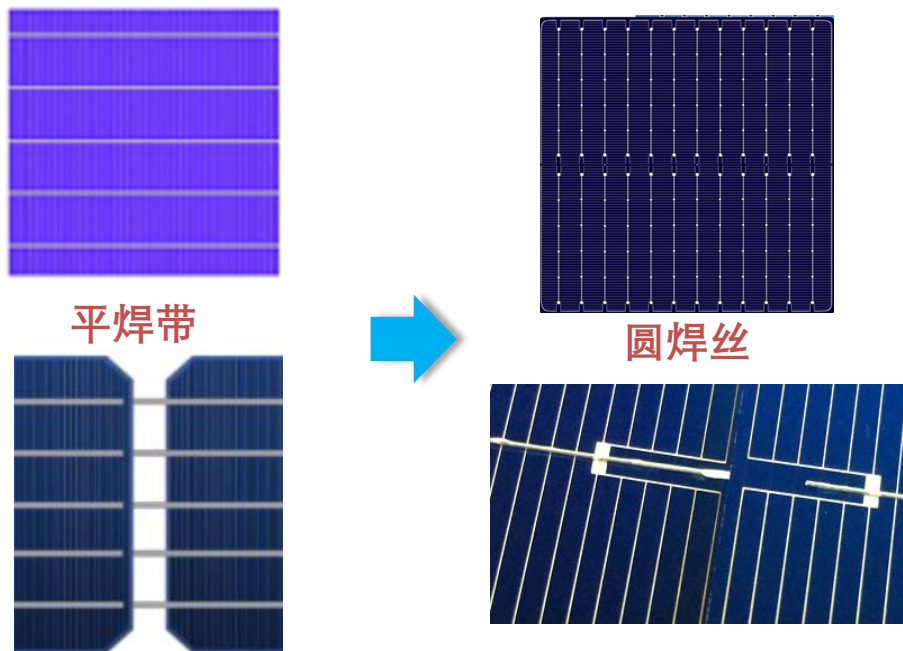


常规电池



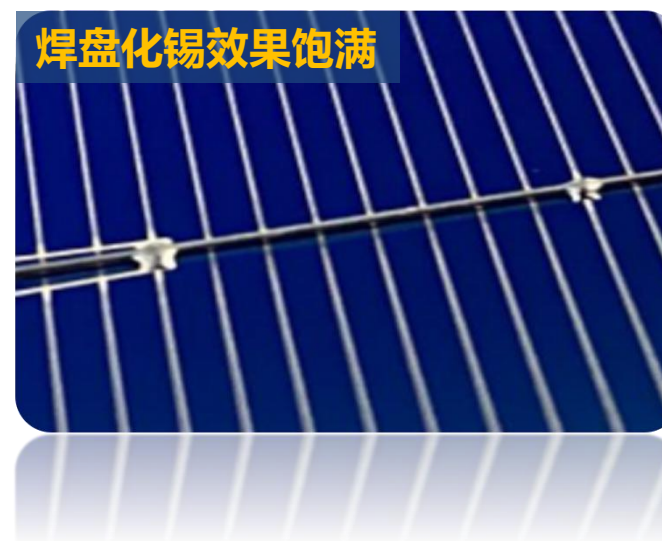
MBB电池





2018年推出的多主栅串焊机，解决了圆焊丝诸多处理难题，使得多主栅组件成为市场主流：

- 更换焊带盘时，快速接续圆焊丝
- 多根圆焊丝拉直
- 圆焊丝头尾放置
- 圆焊丝与主栅线对准
- 电池串输送过程中，圆焊丝位置保持
- 圆焊丝压下
- 焊接良率
- 圆焊丝热胀冷缩



多主栅串焊需要解决的问题



圆焊丝牵引: 拉直、切割、牵引、放置...

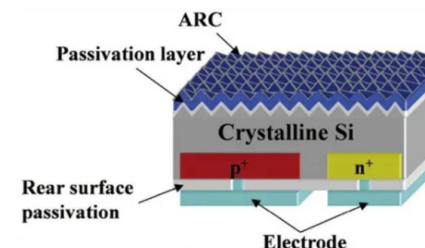
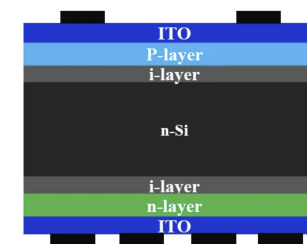
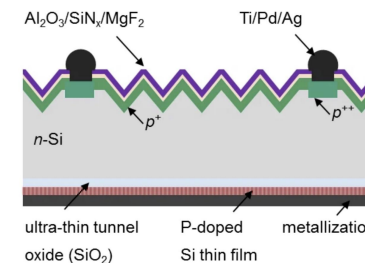
露白: 电池片检测、焊丝定位、电池串输送...

焊接: 压持、拉力、良率...

碎片率: 焊带直径、折弯...

产能: 放片、牵引、输送、焊接...

| 序号 | 电池类型 | 组件工艺变化 |
|----|--------|---|
| 1 | TOPCon | 与PERC工艺相差不大 |
| 2 | HJT | <ol style="list-style-type: none"> 1. 解决激光划片损耗大的问题 2. 解决低温焊接问题 |
| 3 | xBC | <ol style="list-style-type: none"> 1. 增加印锡膏工序 2. 焊带交替放置 3. 电池片翘曲控制 |
| 4 | OBB | <ol style="list-style-type: none"> 1. 增加印胶工序 2. 在层压机内实现焊带与栅线的连接 |



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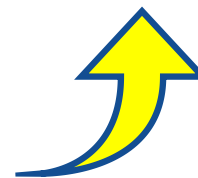


组件装备的发展趋势 产能越来越快



划片机

12000 片/小时

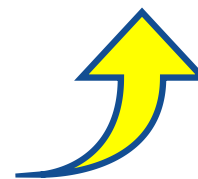


3600→7200



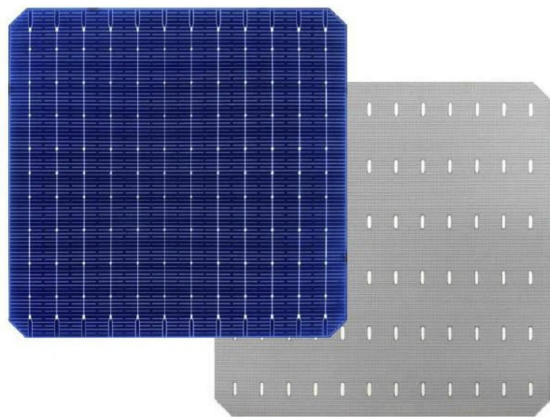
串焊机

10000+ 片/小时

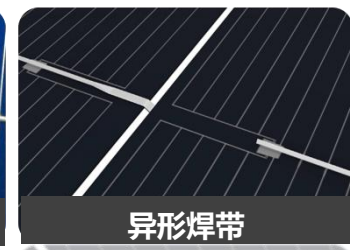
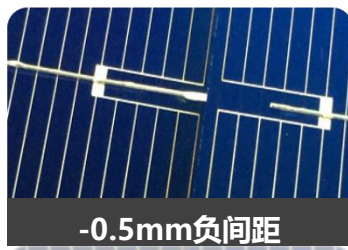
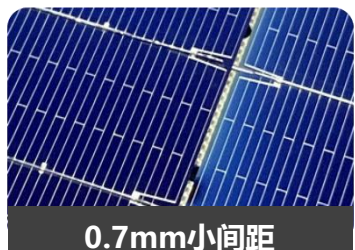


片/小时

600→720→1300→2000→6400→7200



- ◇ 电池兼容：PERC / TOPCon / HJT
- ◇ 尺寸兼容：156-230mm
- ◇ 厚度兼容：120-180 μ m
- ◇ 栅线兼容：常规主栅 / MBB / SMBB / OBB
- ◇ 焊带兼容：扁焊带 / 圆焊带 / 异型焊带
- ◇ 间距兼容：常规间距 / 小间距 / 负间距
- ◇ 规格切换：模块化切换 / 配方一键切换





高产能

高速生产状态下，对识别、抓放、输送速度、精度及稳定性要求高



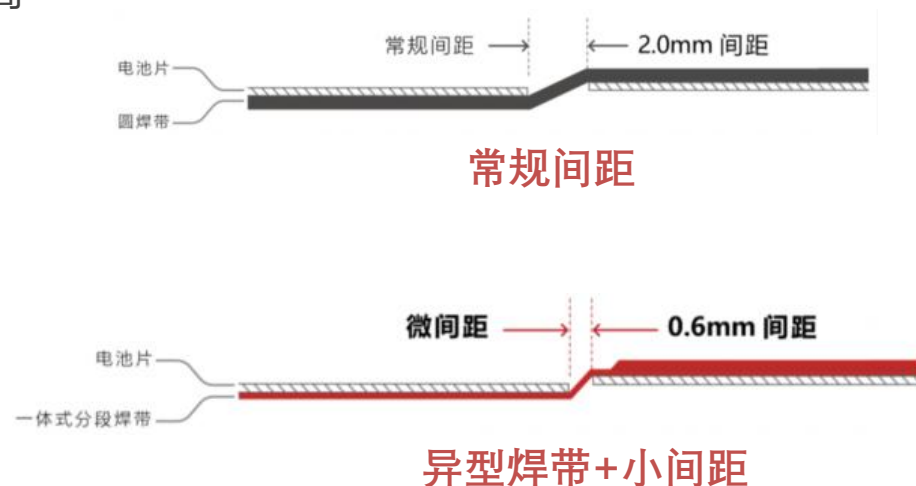
小间距 / 负间距

对串间距精度要求高



多主栅

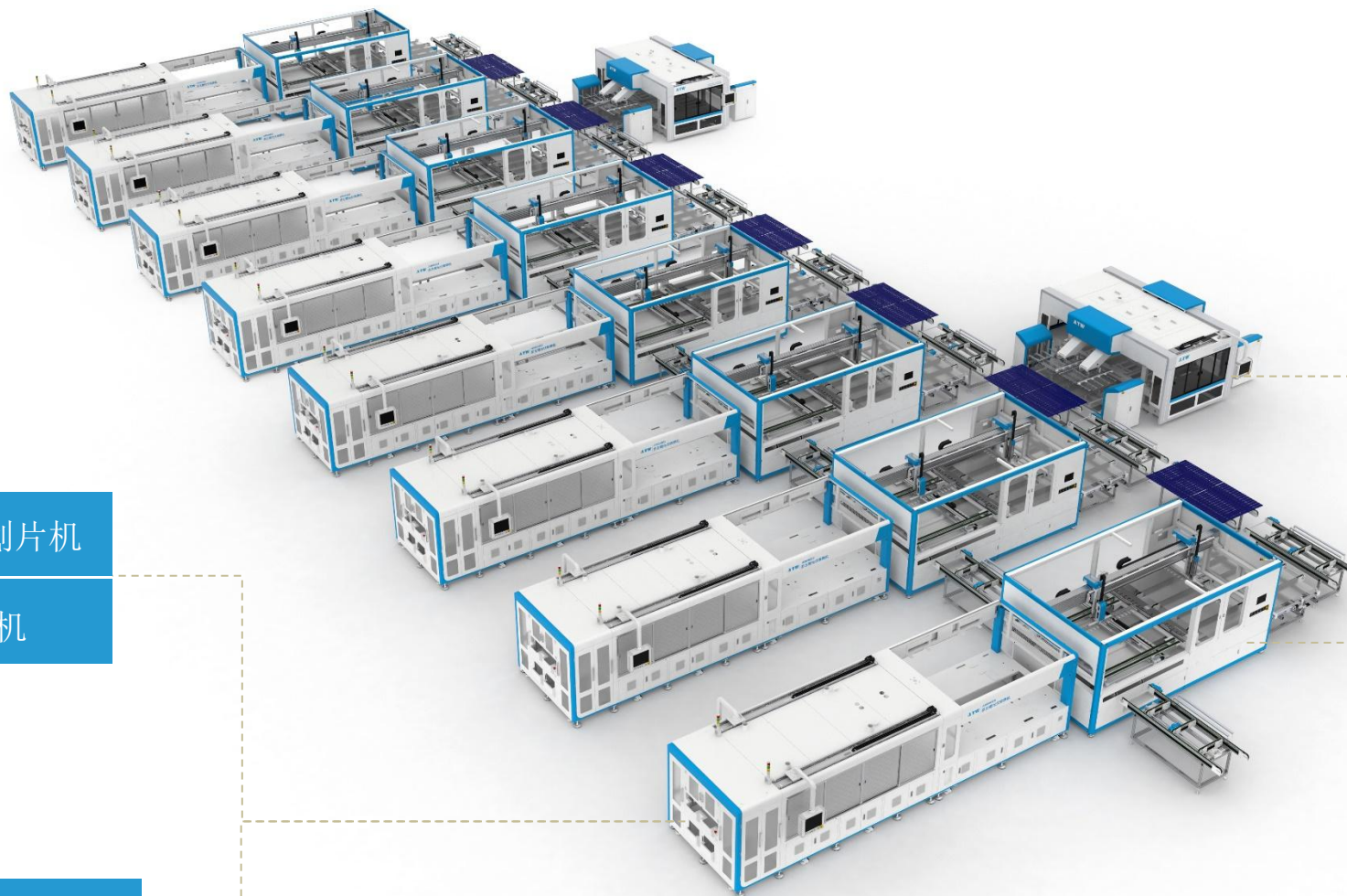
对细焊带整形质量及焊带对位精度要求高



- **高精度机器视觉系统与图像检测算法：**实现电池片精确检测
- **高速机器人与运动控制算法：**实现电池片精准定位
- **柔性抓取机构：**实现电池片稳定抓放
- **焊带随动托举机构与高精度直线对位系统：**实现焊带稳定整形与精确对位
- **随动整面焊带工装：**实现焊带与电池片稳定输送

组件装备的发展趋势

划/焊/排/叠一体化



高速无损划片机

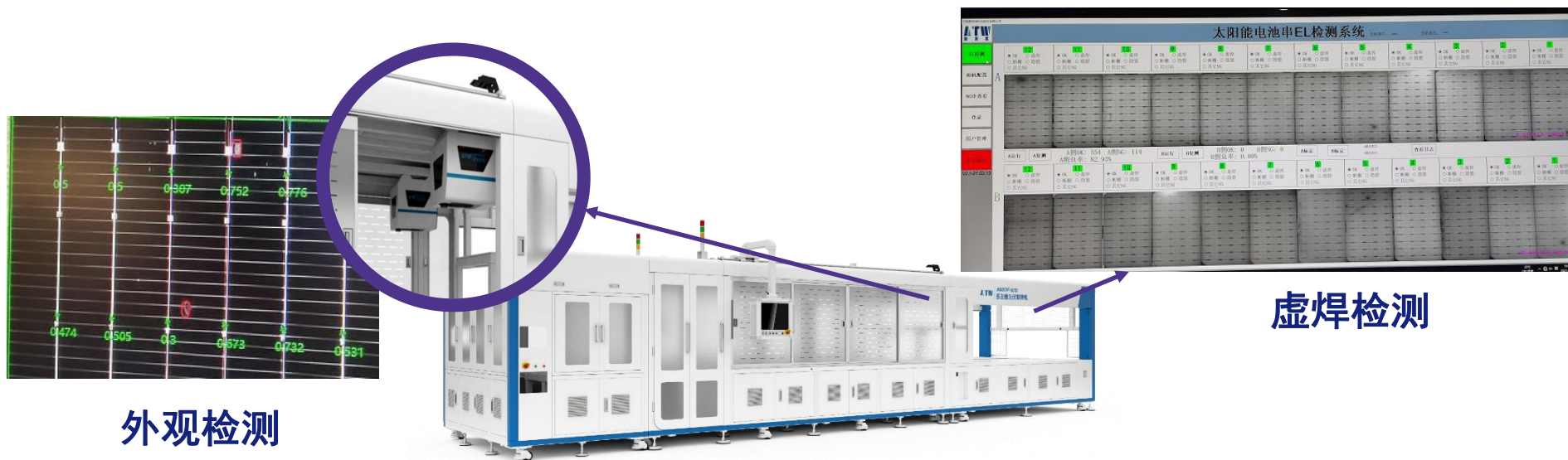
高速串焊机

划焊联体高速串焊机

高速叠焊机

高速排版机

基于AI技术的焊接质量检测，代替人工目视检查



串焊数据集中监控与分析系统





THANKS