Process machines and automation systems by Manz offer many advantages for customers in the photovoltaic industry. They are characterized by maximum efficiency and reliability. Maximum process quality and, at the same time, low cost of ownership are evidence of the high level of development and well-designed system solutions.

The presence of the Manz group, with its own production facilities in Germany, Slovakia, Hungary, Taiwan and China, as well as worldwide service centers, guarantees short response and delivery times. You too can share in the benefits.
Manz's products combine both an increase in efficiency as well as significant savings. This means we offer our clients around the world the ability to meet their increased competitive demands.

**POWERING INNOVATION**

Manz offers its entire range of services for the efficient manufacture of thin-film solar modules under the Total Fab Solution concept. Based on long-term experience in the development and implementation of automation solutions for entire factories in the FPD industry, Manz can offer a wide-ranging portfolio of products for glass handling, storage and buffering of glass substrates, and conveying equipment. In addition, Manz offers equipment for mechanical scribing of CIS and CIGS layer systems as well as equipment for laser scribing and laser edge ablation for all established thin-film systems (aSi, aSi/μcSi, CI(G)S, and CdTe), and laser cutting equipment for cutting glass substrates. Wet-chemical equipment to clean coated and uncoated substrates as well as pre-etch the TCO layer completes Manz’s range of products.

The Manz Group is the global market leader for laser-scribing equipment, with an estimated market share of more than 50%, and sets international standards when it comes to equipment for manufacturing thin-film solar modules. Within the value chain, Manz’s products will cover approximately 90% of all investments made, including the new vacuum coating systems of Manz Coating.

**KEY FACTS**

- **Year of Foundation**: 1987
- **Headquarters**: Reutlingen/Germany
- **Core Competencies**: Robotics, motion, metrology, control, process technology
- **Worldwide locations**: Germany, China, Taiwan, USA, Spain, Slovakia, Hungary, South Korea, India, Israel

**PHOTOVOLTAIC TFS SOLUTIONS**

**THIN-FILM SOLAR MODULE PROCESS STAGES**
FAB AUTOMATION

When developing new concepts, our focus is on the economical manufacture of solar cells and modules. The resulting cuts to production costs contribute bit by bit to grid parity being reached.

Manz can look back on a long, successful history of providing automation solutions for the FPD industry. Our automation solutions have now been on the market for more than 15 years. And Manz has been successfully applying exactly this expertise to the field of photovoltaics for many years.

The newly developed concept of a central automation corridor for Fab automation provides many advantages for our customers:

• The cassette buffer system allows “chaotic storage”. With this system, you can save significant amounts of storage space and work more efficiently and cost-effectively.

• The central buffer concept offers our customers an improved degree of flexibility. The central robot unit is in a position to reach every substrate cassette in the central corridor within a very short period of time and to transport it to the next process stage. This allows very short cycle times to be achieved.

• The enclosed cassette stations can be purged with inert gas or dry air, as required. This reduces the clean room class requirements for the entire Fab, which also represents a considerable cost advantage.

• The new central automation corridor by Manz is modular and can be extended as required. This concept can also be applied to different glass sizes.

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PROCESSING SOLUTIONS

LASER SCRIBING & MECHANICAL SCRIBING

Manz's scribing systems are optimized for the highest level of precision – for every scribing process needed during the manufacture of thin-film solar modules. And Manz's equipment can be used for both high-precision mechanical (P2, P3 for CIGS substrates) as well as laser-based (P1, P2, and P3) scribing.

During the manufacturing process, active tracking (Manz's Inline Precision Control System) allows dead areas to be reduced by 150 μm - 300 μm, a new milestone compared to other systems on the market. Doing so significantly increases the efficiency of the solar modules. Low operating costs are just one of the many benefits of Manz's scribing equipment. High throughput and maximum efficiency are valued by long-term Manz clients. This is primarily the result of the parallel processing, which allows tact times to be reduced while still maintaining the high level of quality.

Another notable characteristic, in addition to the high-precision processes and the high quality of the products, is the equipment's sophisticated and flexible design. It allows the equipment to be easily integrated in completely automated production lines.

LASER SCRIBING

Manz scribing tools demonstrate by lowest non-productive times due to on-line alignment, loading and unloading in parallel and ease of maintenance.

Highest throughput and efficiency:
- more than double the throughput than most competitors due to number of beams/tools in parallel and scribing speed
- accuracy/precision during scribing (alignment procedure; mechanical design of the stage; control)

Most robust process: choice between different laser sources (ns/ps) allows biggest process window.

Smallest dead area due to Inline Precision Control System (IPCS):
Dead area < 200 μm possible, depending on design file; approx. 150 – 300 μm less than competitive tools

MECHANICAL SCRIBING

- Modular design and integrated vision systems, high throughput
- High positioning accuracy of lines, vision systems for highly accurate positioning of the substrates
- active alignment of P2/P3 scribe during scribing process
- Parallel processing with mechanical multiple tools for flexible adaptation to throughput
- Integrated quality assurance (resistance measurement; optical inspection)

NEW: M-IPCS – Inline Precision Control System for tracking of mechanical scribes
LASeR eDGe ABLATION

An extremely reliable laser edge ablation process is required to manufacture high-quality thin-film solar modules. This process, which is carried out prior to laminating the glass cover, ensures that the coated glass is well isolated.

Conventional methods of edge ablation, such as sandblasting or grinding the edge, require a lower initial investment; however, due to their high operating costs, they are less economical over the long term. In addition, the edge ablation process using these methods has drawbacks – such as reduced product quality and productivity.

In comparison, laser edge ablation equipment from Manz has been a fixture on the market for many years, and is well known for its extremely high level of performance and reliability. Cutting rates of up to 60 cm²/s can be achieved with these systems. During the laser edge ablation process, the glass is neither damaged nor negatively affected. High process accuracy, cost effectiveness, and low tact times are the decisive advantages of Manz’s laser edge ablation systems, which can be used for all currently available thin-film substrate sizes.

The laser edge ablation systems by Manz, which are used for the electrical insulation of thin-film solar modules, are highly productive – with ablation rates of up to 60 cm² per second. The ablated surfaces also show a high level of transparency. The glass is not damaged by the edge ablation process and we can guarantee you top process quality as well as reliability.

The ablation system includes:
- Vision systems for highly accurate positioning of the substrates
- Linear motor drives for highest dynamics
- Programmable ablation rates and areas
- Gentle glass transport
- Inline configuration
- Fast load/unload of substrates to minimize secondary time
- Efficient suction of particles
- Low operating costs
- To customize process different laser sources available
- Speed to move in substrates up to 1.6 m/s

LASeR GLASS CUTTING

The glass edge has a tremendous impact on the mechanical strength of the substrates. State of the art is mechanical cutting, breaking and grinding of the substrates. But this process causes defects and is the origin of cracks and breakage.

However, full body laser cutting of glass avoids micro-defects providing an up to 2.5 times higher bending strength! Manz supplies glass cutting systems based on a laser cutting process. Due to the full body cut, a mechanical breaking is not required at all and micro-defects are minimized within this process.

The advantages of laser cutting: no micro cracks, chip free edges, higher bending stability, less sensitive to temperature variation, different cutting shapes are possible. No polishing needed. Contact free cutting, waste free cutting.

Processing Solutions

Two in one available:
- laser edge ablation
- plus laser glass cutting

Unbeatable advantages – contact free cutting, waste free cutting
Optical inspection is the natural replacement of human visual control when leaving small volume pilot productions and going over to large scale manufacturing. The IQ Inspect system uses leading edge inspection technology to locate and classify any irregularities on the surfaces and edges of your glass substrates.

Avoid glass breakage and down times by separating defective glass sheets; optimize cleaning processes and subsequently the device quality by monitoring sheet contaminations; improve productivity by discovering systematic failures and recognizing process drifts on a short time scale. Your benefit as customer gets even higher choosing the whole scope of supply of Manz.

**GLASS INSPECTION SYSTEMS**

**IQ Platform:**
- Quality control based on multiple testing tools
- High-level result summary, analysis & classification
- Modular concept – Highly customizable to fit your needs
- Different strategies for full substrate mapping at inline throughput
- High accuracy positioning of substrate & test heads
- Inline testing of powered-up devices possible
- Line integration as fully-automated tester or stand-alone portals
- Perfect integration in the Manz total fab solution

**IQ Inspect:**
Current efforts to reduce production cost and improve the efficiency of thin-film solar modules focus on an increase of the active cell area and on processing with higher throughputs. Generally, a side effect of these optimizations is the narrowing of process windows. In order to maintain the targeted production yield, a tighter process control is required.
- Full area quality scan at high speed
- Leading edge inspection technology
- High precision measurement of panel geometry
- Powerful and intuitive software
- Robust setup with industry proven components

**IQ Scribe Tester:**
- Inline inspection tool with full area scribe inspection
- Leading edge inspection technology
- High resolution measurements of scribe dimensions (width, scribe-to-scribe distance)
- Verify electrical insulation between scribes
- Powerful and intuitive software
- High-level data analysis
- Robust setup with industry proven components
With over 20 years of experience and more than 400 pieces of equipment delivered and installed, Manz Taiwan is one of the largest suppliers of cleaning and etching equipment for the FPD and PCB industry, which gives the Manz Group access to extensive expertise in the field of wet chemistry.

Using this expertise, Manz has developed innovative wet chemical equipment for manufacturing thin-film solar modules. This includes systems for cleaning glass substrates and systems for pre-etching the TCO layer.

Both systems are characterized by a number of benefits in comparison to conventional equipment: Their compact size and modular design allow the machines to be integrated into existing production lines efficiently and in a way that saves space. Both glass-cleaning and TCO etching systems are available for all common substrate sizes. It goes without saying that the systems were designed for maximum throughput and productivity and that they fulfill the highest demands of the PV industry. The systems’ well-engineered design reduces the need for consumable parts and cuts operating costs.

CLEANING AND TEXTURING TECHNOLOGY
The so-called level 2 machines of the successfully introduced GCT series (“Green Cleaning Technology” for cleaning) and the GTT series (“Green Texturing Technology” for the TCO treatment after PVD deposition) is based on the proven modular conception of the first generation. However, significant developments and improvements were integrated into the level 2 design.

GREEN CLEANING TECHNOLOGY (GCT)
- Excellent cleaning result on removable material (particles, glass separation material (Lucite), organic contamination)
- Performance of sophisticated process requirements, highest safety standards combined with simple operation and easy maintenance
- Small investment costs because of possibility to adjust the equipment exactly to process requirements
- High productivity times and process repeatability ensure excellent yield with constant product quality
- Low cost of ownership and short installation/commissioning times
- No cross contamination or corrosion inside the equipment in combination with high throughput and very low breakage rate

GREEN TEXTURING TECHNOLOGY (GTT)
- Efficiency increase of the silicon thin film modules by simple expansion of the product line with TCO deposition and texturing, later upgrade of existing production lines possible
- GTT series fulfill highest process and safety demands combined with easy operation and maintenance
- Small invest and best cost/performance ratio due to the possibility to adjust the tool exactly to process requirements
- High productivity combined with high throughput and process repeatability ensure high yield and continuous high level of product quality
- Low cost of ownership and fast production availability after installation and commissioning
- No contamination or corrosion inside the equipment and low glass breakage rate minimize tool down time and service

WeT CHEMICAL SOLUTIONS
CLeANING AND TeXTURING TeCHNOLOGY

Highest throughput in the market
Low cost of ownership, excellent results
Less chemical consumption due to optimized tank system

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