

# Goodbye to thin film

Grenzebach is a corporation with five production plants in three continents, more than 1,500 staff and a global customer base. The German-based company is a leading manufacturer of line and equipment for the production of flat and float glass, front- and back ends for thin film lines in many different technologies. Now Grenzebach presents its new laser edge deletion system for thin film modules to enhance its thin film portfolio ...

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As a result of rising demand for laser edge deletion systems in the thin film industry, Grenzebach recognised huge market potential and expanded its product portfolio with a new innovative laser edge deletion system. Most edge deletion systems are either based on sand blasting or grinding systems.

This procedure offers on first view a practical solution. On a second view, however, the operator has to deal with consumables like sand, lots of dust in the cabin and also big problems in terms of cleaning and recycling of the consumables. Toxic material gives the entire application a bad reputation. Therefore the industry is looking for alternatives to provide a secure module for the consumer and a healthy and safe workplace for the operators.

Grenzebach's new laser edge deletion system is covering all the above thin film technologies. During the market research Grenzebach was focusing on a solution which enabled an excellent ablation of all practical thin film layers and obtained the requested resistivity.

For the forthcoming PVSEC in Valencia, Grenzebach will display the new development of the laser edge deletion system in a technology circle. The technology circle contains robotic solutions with touch less gripper application, a cassette shuttle with a cable-free energy supply as well as an Algoscan surface inspection system. In

addition there will be a new Ultrasonic welding system on display to present new technologies for a JBOX mounting application and rail bonding system.

During the concept phase, the focus of R&D engineers was concentrated on the flexibility of the size range and the reduction of the floor space.

Due to these reasons the system was designed with a vertical conveying system which guides the substrate in the longitudinal direction through the Nd:YAG-Laser. The laser head is mounted on a vertical running linear axis which moves up and down for the short edge ablation. The ablated thin film material is absorbed by means of a vacuum system on the opposite side of the laser head and moves synchronously with the laser head axis. The vacuum system comprises all necessary filter systems and efficient vacuum energy to warrant a healthy and safety workplace for the operator. The system is completely in-housed for Laser class 1 to ensure complete safety during the ablating process. As a matter of fact, thin film lines have different cycle times, sizes and thin film technologies. Grenzebach is able to present customised solutions for different requirements.

The selection of ROFIN as an experienced supplier for the laser sources was a well thought-out decision. The advantage of ROFIN is

the variety of laser sources from 200W up to 1000W, the fundamental know-how based on more than 35 years' experience and the global presence of the company. The different laser power enables customised solutions for different cycle time requirements. In addition the high end laser sources can be split into two laser beams to serve two laser edge deletion systems at once. This method reduces a major impact of costs.

## ROFIN's laser source

For electrical isolation and hermetic sealing of the module, the complete removal of all layers from the edges of fully processed thin film solar cells on glass substrates is required. In order to meet production requirements of a typical 40 MW p.a. manufacturing plant, removal rates have to be in the range of 10-50 cm<sup>2</sup>/s. Here, the laser challenges conventional techniques, like sand blasting and grinding. Since standard TEM00-lasers (like Nd:Vanadate lasers used for scribing) do not provide sufficient ablation rates for this application, especially developed high-power qs-lasers are applied.

The process of the laser edge deletion system starts in a vertical transport conveyor which is driven by belts. The vertical orientation offers two advantages. The first advantage is to run the substrate without any alignment because the edge of the substrate

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moves on a timing belt and enables an ideal reference edge for the horizontal edge deletion. The second advantage comprises the limited space consumption for large-scale substrate. Here, Grenzebach is using the height of the building instead of the area.

The two opposed and vertical-oriented linear systems are containing on the top side the vacuum system and on the back side the laser head. The Nd:YAG q-switched laser source is located outside of the LED system. The connection of the laser source and the LED system is achieved through an optical fibre cable which transmits the diode pumped solid-state laser into the collimating system inside the LED cabin.

From there the laser beam is switched into a Galvo-scanner and is corrected afterwards by means of a flat field lens. The laser beam passes through the substrate and hits on the other side the very first layer like Molybdenum or the TCO. This method achieves best results in terms of ablating the different coatings because only the first layer is heated and as a result the other layers are blasted away towards the vacuum system. The pulsed laser beam itself has a size of a square which is position-controlled by the Galvo scanner.

Typical ablation widths are between 0.7 and 1.5 mm at processing speeds of up to 4000 mm/s. As the nature of the process is a shot-by-shot application, a square spot geometry has the advantage that the overlapping of several pulses is constant across the processing direction. Processing with square homogeneous spots from square fibres allows the optimisation of removal applications. Overlapping of pulses is realised by a displacement of subsequent pulses less than one spot width. Square pulses have the advantage that the overlap is constant from the centre of the spot to the edge. Efficient and homogeneous removal results are achieved easily.

On the top side axis the vacuum system is established with a stainless steel



nozzle which is located very close to the substrate and enables a perfect stream of the suction air towards the filter system. The filter system is divided into three sections. An automatically cleaned coarse filter refines almost 95 per cent of the particles which were ablated by the LED system. The second filter contains a HEPA filter and removes at least 99.97 per cent of airborne particles with a minimum size of 0.3 micrometers ( $\mu\text{m}$ ) in diameter. Last but not least an activated carbon filter eliminates gaseous substances. The exchange of the coarse filters bag is contamination-free and the operator will be signalled that the filter should be exchanged.

The entire system is completely equipped with a complete housing to fulfil the laser class 1 requirements. Entrance and exit of the conveyor is logged by means of a load lock to keep the environment clean. Optional Grenzebach is providing a camera system for the process monitoring to show the operator the interior room of the LED system at the operator control desk. The PLC of the system offers interfaces to the line automation and also to the MES system. Grenzebach's HMI software PCPANEL2 allows a user-friendly operation of the LED system.

For future applications Grenzebach is concentrating also on a laser solution for the side edge deletion specifically for CIGS and CdTe customers who need to have a clean side edge for a frameless thin film module. The option is only possible as a combination with the



laser edge deletion system and with a particular substrate edge.

Grenzebach is focusing on a wide range of customers with different cycle time criteria and different thin film technologies around the world. The automation specialist is also able to provide customised solutions for special applications. High-quality machineries, low cost of ownerships and a worldwide operating service team are part of Grenzebach's philosophy to keep a great customer relationship. ■

For more information, visit: [www.grenzebach.com](http://www.grenzebach.com)