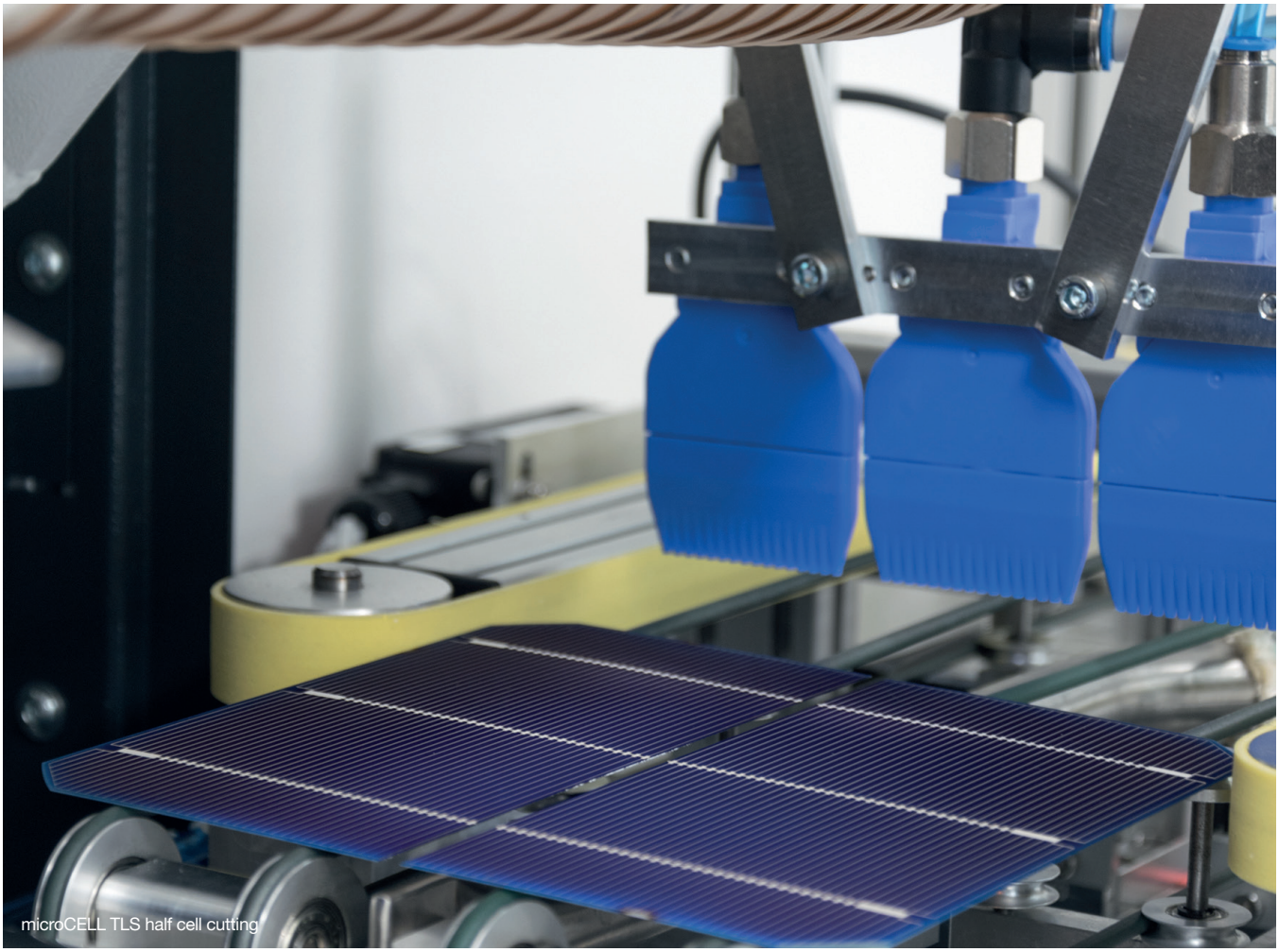

microCELL TLS half cell cutting

Leading the way in precise laser micromachining

PES met up with Frederick Bamberg, Product Manager at 3D-Micromac AG in Chemnitz, Germany, to discover the advances in laser machines and processes in relation to the PV industry. Efficiency and cost savings are being achieved through listening to the customer, R&D and expertise.

PES: Welcome back to PES Solar/PV magazine. For the benefit of our new readers would you like to begin by explaining a little about the importance of the solar industry to 3D-Micromac?

Frederick Bamberg: The PV industry is one of our key markets and accounts for approximately 30% of our business. Within in few years 3D-Micromac succeeded in establishing itself amongst the Top 3 manufacturers of laser equipment in the solar industry.

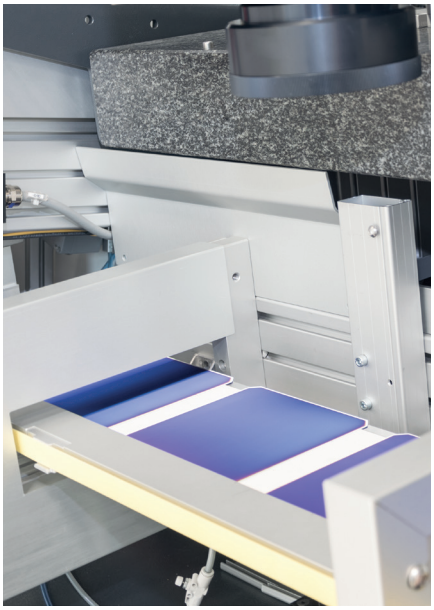
We offer different machine concepts for the various fields of the PV industry. For example, our customers in the c-Si/wafer based segment prefer our microCELL OTF and microCELL TLS platforms for PERC-LCO, innovative cell cutting as well as doping. Those in the TFPV segment prefer the microSTRUCT LS for thin films on glass panels as well as the microFLEX family for thin films on flexible substrates.

Apart from these established mass production tools, we also offer fully flexible platforms to R&D centres in the sector. Currently we are also working on an elaborate, fully customised tool, for a special PV pilot line. The customer benefits from this broad variety of expertise and process know how.

PES: We would like to know what makes your laser equipment stand out from the competition?

FB: Our philosophy is completely different from our competitors. We grant the customer a much wider flexibility; our platforms match

Demo center at 3D-Micromac's head quarter in Chemnitz, Germany, with automated laser tools of the microCELL family for PERC ablation, doping and half-cell cutting



Kept simple: interior of PERC-LCO laser tool with contactless continuous motion wafer transport

precisely the specific needs.

Also they are far from being just a rebuild or simplified version of existing tool concepts, as is often the case.

When designing the microCELL concept we looked at the disadvantages of current systems on the market and gathered feedback from production engineers and operators about their most important but, to date, unmet expectations. So with this tool concept, the customer benefits from a basically contact less wafer transportation, as well as processing in continuous motion. The benefits are obvious: scratches and micro cracks are avoided while the throughput is boosted by ~20%.

PES: Could you please explain in more detail how these unique features create a benefit in mass production? Are these of value to all cell manufacturers?

FB: Well, at least to the ones care about quality and yield in their production. Those customers that would rather look at the cost of ownership at mid-term than initial investment only. I am always surprised at how often engineers in charge, have got a limited awareness of the damage grippers, pickers and vacuum chucks cause to their cells at the laser step.

Maybe this is because after the LCO step comes the screen printing. People might see the printer/the print nest as the root cause of increased breakage rates, although hundreds and thousands of cells simply break under the squeegee pressure because the previous laser machine created unnoticed micro cracks. The problem is even harder to detect if you think of using an eight nests rotary table in your laser. One particle, on one chuck, damages every eighth cell that later on breaks in one of three printing steps. Questionable tool design of the laser equipment is hidden in the relatively high yield loss seen in the metallisation step.

When using the microCELL OTF platform, the wafer is hovered onto an air film through the machine, so no active force is applied which could cause damage. The other benefit of throughput increase becomes obvious if a customer aims for dense LCO patter and/or expansion volume in the GW range, by avoiding stand by times for the laser source for the movement cycles. You simply need one tool less meaning lower operator costs, foot print, and depreciation.

PES: Interesting! Do you see such topics like quality and throughput currently attracting more attention in the solar industry?

FB: For sure. Despite the impressive growth rates of the end customer market and its matching expansion on the solar cells and module production capacity, the end customers are not forced to buy anything available.

Competition is strong, so on one hand cell makers are aiming to improve their step costs by increasing the yield, on the other hand, banks and project developers carefully look at the quality of the solar panels. There have been too many cases of severe power losses in solar parks and failing modules. The financial plan is based on an operation over 20 years or more at a defined power degradation over that time span. Anything that helps reduce the loss of generated power over time represents value. Similarly our innovative and patented cell cutting process means an increase in the mechanical strength of modules.

PES: Is this the Thermal Laser Separation (TLS)? You won the Megawatt Prize for Outstanding Half Cell Cutting Technology at SNEC 2016, what has happened since then?

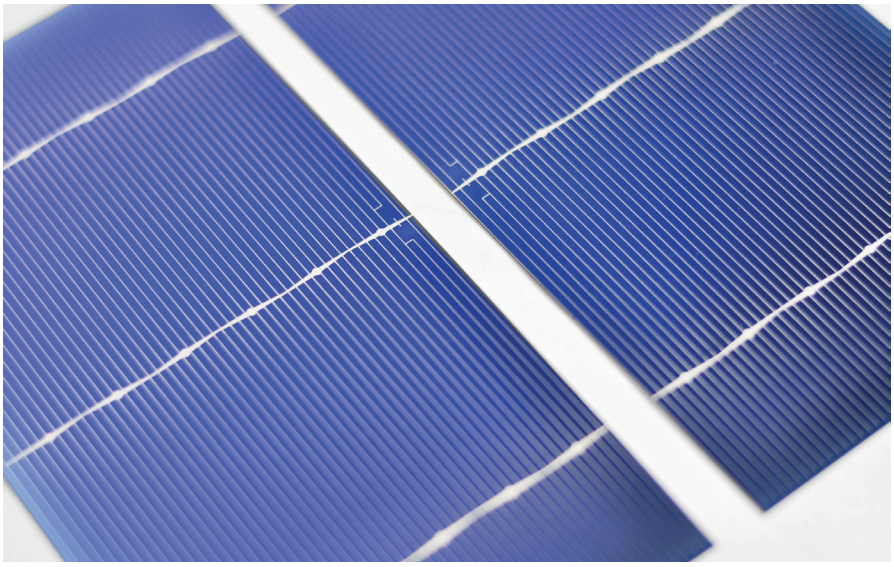
FB: Yes we did. Cleaving by thermal stress rather laser ablation and breaking with force. The technology attracted a tremendous interest in the industry. As you would expect, clients wanted to sample the technology on their own material to confirm the advantages.

TLS machines went to R&D institutes and together with industrialisation partners we successfully transferred this technology to mass production. The initial microCELL TLS machine got an update, which became the new standard, based on all lessons learned from the experience of dozens of millions of cells.

It's an honour that competitors started to look for a work around our patent portfolio and started similar research. In comparison tests we are still able to see the lead our process has against these trials, but it underlines that the former standard process of laser ablation is at the end of its life cycle. Again, at least for quality concerned companies.

PES: What are the main advantages of these types of machines in comparison to others – are they durable, cost effective, more efficient etc?

FB: Compared to today's standard process of laser ablation, the main benefit is the approximately 30% higher mechanical strength of the half cell. Basically the force



TLS cut half-cells achieving more than 1 watt additional module power compared to conventional scribe and break methods

remains the same on half cells cut by TLS, as it was on the original full cell. However, the breakage force value decreases drastically when cutting a cell by scribe and break, caused by micro cracks introduced when actively breaking the remaining part of the laser grooved cell.

By using 3D-Micromac's TLS process, module manufacturers are able to guarantee a lower power degradation value over the time a module is operational. On the other hand the nominal module power starts at a higher level. In addition to the 5-7W gained by the half cell design, due to reduced module current, we found an average of approximately another 1W in a 60 cell module, as on each cell the electrical losses at the cut surface is reduced.

Furthermore, there is a smaller surface due to the smooth appearance of the homogeneous split crystal, as well as the lack of defects in molten and then recrystallised material in the ablation zone. As the heat level is much lower, this is specifically another benefit for heat sensitive cell concepts like hetero junction technology. The gains multiply, if you think of smaller stripes than half cells, as the amount of defects per cell volume represents a higher share, the smaller the pieces of a solar cell are.

PES: Please could you also tell us about the tool concept? What does a module manufacturer can expect there?

FB: The microCELL TLS uses a high speed splitting process without the need to have a slow scan speed, or multiple passes, as seen in laser ablation. At 300 to 500 mm/s you end up with being limited by the ability of the handling automation to load a maximum number of cells onto our single lane tool. And unload twice the amount of half cells.

The current automation achieves values well above 10,000 half cells per hour. So the benefit is that one tool replaces three to four of the competition. Apart from that, keep in mind, the process does not create huge amounts of dust, as in the former process. All those frequent filter changes, downtime for cleaning cycles, health and safety considerations means that Thermal Laser Separation is setting the new standard in cell cutting!

PES: And would you say, there is a trend in the industry to go to such module designs with half cells?

FB: Definitely! Wouldn't you? It's not just like this, that at each trade show most manufacturers display such modules. It's really something you can buy in high volume already. And the market share in increasing.

About 3D-Micromac

3D-Micromac, with headquarter in Chemnitz, Germany, is the leading specialist in precise laser micromachining. Target markets include the photovoltaic, semiconductor, glass and display industries, as well as micro diagnostics and medical technology.

There is worldwide network of distributors guaranteeing service and close contact with the customers.

A strong in-house R&D division provides innovative processes and machine concepts which means 3D-Micromac is able to offer unique solutions to its customers.

www.3d-micromac.com

www.lasers-for-photovoltaics.com

After the boost in module power by converting Al-BSF (Aluminium Back Surface Field) technology based production lines to PERC (Passivated Emitter and Rear Contact) on the cell side, this is the corresponding technology change at the module level.

Whereas for PERC technology one had to invest in a passivation layer deposition tool and a laser for opening it locally, converting to half cell modules requires cutting lasers and additional stringers. Implementation is straight forward because the existing production lines are supplemented and not replaced. And module power is key for reducing the costs per Watt peak. Going to half cells is a manageable investment with a return in typically less than a year.

PES: And looking to the future?

FB: I think the whole community can be proud off having brought solar energy to this milestone level of 100GW production capacity and its financial competitiveness against other sources of energy generation.

The market conditions, technology, geographically, politically, financially, etc are still changing fast and the door is open: you are more than welcome to join in.

I'd like to give my profound thanks to all our customers and partners worldwide for their trust in 3D-Micromac and their belief in the technology changes. Whether it is in innovative wafer transportation or a newly developed cutting process.

Remember for any laser solution, standard or customised, wafer based or on sheets as well as foils, do not hesitate to contact us.

Frederick Bamberg studied MEMS at Albert Ludwigs University Freiburg and obtained his degree in 2004.

From 2000 until 2006 he worked in different research groups at Fraunhofer Institute for Solar Energy Systems (ISE) in Freiburg, Germany, BP Solar in Sunbury, U.K. and the University of New South Wales (UNSW) in Sydney, Australia, before working as process engineer at Solarworld in Freiberg, Germany, from 2007 to 2015.

In 2016 he joined 3D-Micromac AG in Chemnitz, Germany, as product manager. He is in charge of PV industry related laser machines and processes.