We think that PERC cell architecture will become increasingly the focus of the solar cell manufacturers. Chinese tier-1 manufacturers will surely upgrade or add PERC solar cells to their product portfolio in the short term, which most Taiwanese and European players already do. Some of the manufacturers will take this point into account especially when they decide on production expansion in other Asian countries. A boost in production of PERC cells will also come when low-cost solutions for PERC production equipment: It’s a surprise to no-one that PERC market share is growing and growing fast.

However, with rapid adoption comes challenges, which includes equipment suppliers keeping up with a spike in demand and the resolution of technical challenges such as LID. Centrotherm senior vice president PV sales and technology Josef Haase sets out the German equipment supplier’s technical solutions for PERC.

What demand are you seeing for centrotherm’s PERC technology centaurus among PV cell producers at present?
Josef Haase: Manufacturers of c-Si solar cells are necessarily looking for cost-effective solutions to increase efficiency of their products. This can either be achieved by optimizing processes to a certain extent or by making the next step from the standard solar cell to the production of highly efficient PERC and bifacial n-type solar cells. At present, some of the leading cell manufacturers are turning towards these cell architectures. This is primarily coming from Taiwan and Europe, but Chinese manufacturers are already following.

Centaurus is one of the solutions which centrotherm offers for the manufacturing of PERC cells. The centrotherm centaurus technology is already installed at our customers with a production capacity of more than 800 MW, and is deployed very successfully in mass production. We offer cell manufacturers different solutions for getting into PERC production, which depends on wafer material and process flow. In case the dielectric stack is deposited prior to the diffusion process, we recommend our centaurus SiONx process for back surface passivation of mono CZ-Si cells. If a PERC process flow is used, in which the dielectric stack is deposited after diffusion, we recommend our customers use the centaurus AlOx process. In case of multicrystalline solar cells the centaurus AlOx process is the most cost effective solution.

How do you expect PERC applications to evolve in 2016?
We think that PERC cell architecture will become increasingly the focus of the solar cell manufacturers. Chinese tier-1 manufacturers will surely upgrade or add PERC solar cells to their product portfolio in the short term, which most Taiwanese and European players already do. Some of the manufacturers will take this point into account especially when they decide on production expansion in other Asian countries. A boost in production of PERC cells will also come when low-cost solutions for...
the deposition of the dielectric stack systems are on the market, with €0.05 per wafer being somewhere around the upper limit. The CoO for the centrotherm AlOx/SiNx-PERC solution at below €0.04 per wafer is very low, especially when compared to in-line and ALD solutions. This takes into account that the maintenance costs are much lower since no parasitic deposition occurs and therefore regular chamber cleaning is avoided.

LID in PERC cells has been observed and is potentially problematic. How do you see this issue playing out?
A further boost in PERC cell manufacturing capacity will come from the fact that the LID issue for mono-CZ is solved. The LID in mono-PERC cells is more pronounced since any degradation in the bulk material will lead to a higher degradation effect as compared to Al-BSF cells. So most of the efficiency gain is lost through the LID affect. This is in our view no longer a problem for manufacturers, since centrotherm recently introduced its solar cell regeneration equipment and process for the passivation of recombination active boron oxygen (B-O) complexes in the wafer bulk. This process sustainably reduces LID by up to 80%. Our c.REG regeneration furnace, which is an in-line furnace with a length of 6.1 meters, is already in use in customer lines in Taiwan and has shown very good performance. The integrated solution – fast firing and integrated regeneration of solar cells – was made available at the end of September.
Alongside PERC, some equipment suppliers are confident of the outlook for bifacial technology, which is facilitated with some of the equipment we’ve been discussing. What is your feeling about bifacial technology uptake, even with the existing challenges regarding measuring the precise bifacial power boost in a standardized way?

Bifaciality, especially bifacial n-type solar cells, will come into the sights of solar cell manufacturers as they have a higher power output (10-30%) due to the contribution of the solar cell back side. At centrotherm we believe that BiSoN Technology, which is offered by a cooperation of ISC Konstanz and centrotherm, is one of the most cost effective solutions.

What is the process centrotherm employs in its tooling for the aluminum local back surface field (AI-LBSF) technology?

For the deposition of the dielectric layers in PERC cells, centrotherm uses its batch-type plasma enhanced chemical vapor deposition (PECVD) equipment platform. Our PECVD equipment has already been installed more than 900 times worldwide for the manufacturing of solar cells, so it is well known and well proven in the industry. So far it is mainly used for the deposition of the front side ARC, including PID prevention (SiN, SiON) and backside SiON passivation. For the deposition of AlOx, TMA and N2O is used. Basically, the only modification of our tool is the addition of a TMA cabinet to supply gaseous TMA to our PECVD tool. In our tool, the dielectric stack AlOx/SiNx or alternatively, SiONx/SiNx, can be deposited in one run and in one step by just changing the recipe. This is different to ALD systems. Here only the AlOx layer is deposited and the capping layer needs to be added in another system, mainly also by PECVD. In contrast to other solutions, centrotherm dielectric layers do not require a post deposition anneal (PDA).

So how is the stack system fabricated in our batch-type tube furnace? In the first phase of the process, the AlOx layer is deposited by using TMA and N2O. By only switching the gases to NH3 and SiH4, the SiNx capping layer is formed. So the complete stack system can be manufactured in one run in the same tube. Additional process steps, which can be implemented easily into the recipe, will further increase the benefits of the integrated AlOx/SiNx stack deposited in the centrotherm tube PECVD system. This type of flexibility is unique to batch-type tube furnaces, and we have taken full advantage of it.

There have been reports that PERC upgrades and technology, from certain suppliers, can take up to one year for delivery. How quickly can the centrotherm PECVD tools for PERC production be shipped to customers, and how does it work with existing production flows?
Manufacturers can upgrade all centrotherm PECVD systems quickly and easily with minimum space requirements. Upgrade kits, comprising a space-saving hardware set made up of a TMA cabinet and additional gas lines, can be delivered within two weeks EXW.

The centrotherm solution for a production capacity of 100 MW to 120 MW, consisting of two c.Plasma with TMA cabinets and one twin handling system, is available within a delivery time of less than three months. It has a footprint of around 80 square meters instead of well above 100 square meters for in-line systems.

The integration of the process into mass production is faster and easier if compared to in-line and ALD systems. First of all, the process can be quickly integrated by upgrading one or all tubes of an installed centrotherm PECVD system. As the centrotherm installed base is more than 900 systems worldwide, this should apply to most manufacturers.

During the implementation, the customer dedicates one tube to AlOx and maintains three tubes – 75% of its production capacity. After the optimization of the passivation process for the AlOx/SiNx dielectric stack in one tube, the process can be easily and quickly transferred to the other tubes of the centrotherm PECVD-system.

The efficiency advantage of mono PERC is clearly higher than that for multi. There are also some additional technical challenges to be overcome with mutli PERC as I understand it. Is centrotherm seeing mainly mono PERC deployment or is it also being rolled out for multicrystalline production?

We are convinced that mono as well as multi PERC cells will get a significant market share. Currently, mono is paving the way for multi-Si. Mono is first, since the PERC process is more easily adapted to mono and also the efficiency gain is higher. Multi PERC cells, which inherently have a lower efficiency gain, require a low cost solution for dielectric stacks in order to get a higher market penetration. Therefore, we see our centaurus AlOx solution as an enabling technology.

As mentioned before, we are also rolling out this solution for multicrystalline production. We strongly recommend the AlOx/SiNx process for multi solar cells.

Interview by pv magazine staff