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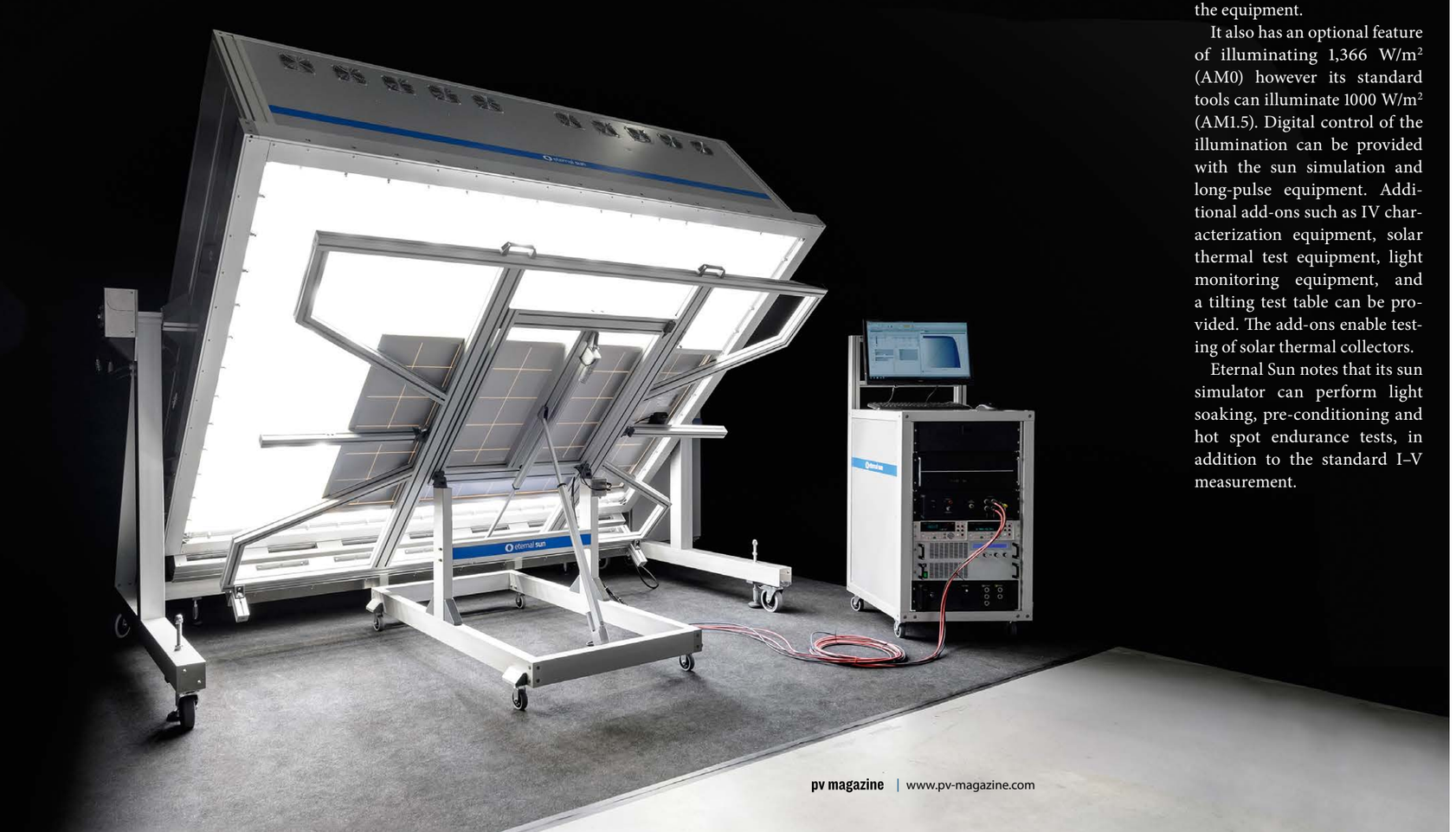
50 Shades of Future PV

Technologies to take your manufacturing to the next level



50 Technology Highlights

Today's top technology to deliver efficiency, innovation and profits: From reducing cost to boosting efficiency, enhancing durability and beyond, pv magazine hand picks a curated guide to the tech on display at the 2015 SNEC trade show and even some that isn't!



1 Eternal Sun for continuous running

Based in the Netherlands Eternal Sun B.V. offers sun simulators that it claims can run for 1,800 hours at a stretch. In March it opened a new head office in The Hague to roll out the technology.

Eternal Sun uses patent pending mixed gas lamps for its AAA-class steady-state simulators for testing thin film and high efficiency PV devices including heterojunction cells. High capacitance PV devices often require longer flashes, which Eternal Sun says are well served by its sun simulator technology. Intgrated air conditioning systems remove heat load and can maintain STC.

The company extends the same features to its long-pulse simulators. Test surface areas can range from 2,000 × 1,500 mm to any size that the customer requires, due to the modular design of the equipment.

It also has an optional feature of illuminating 1,366 W/m^2 (AM0) however its standard tools can illuminate 1000 W/m^2 (AM1.5). Digital control of the illumination can be provided with the sun simulation and long-pulse equipment. Additional add-ons such as IV characterization equipment, solar thermal test equipment, light monitoring equipment, and a tilting test table can be provided. The add-ons enable testing of solar thermal collectors.

Eternal Sun notes that its sun simulator can perform light soaking, pre-conditioning and hot spot endurance tests, in addition to the standard I–V measurement.

2 InPassion delivers 0.2% gain over PECVD AlOx

There is no doubt that PERC retrofits are proving popular. In rolling out the technology Holland's SolayTec is promoting its ALD Al_2O_3 solution, arguing the InPassion tooling and process can deliver a 0.2% efficiency boost over the AlOx alternative.

This efficiency boost, says SolayTec is vital in that it justifies the additional annealing processing step. To further advance this argument, SolayTec says the annealing can be easily integrated, particularly if the customer uses a Tempress direct PECVD furnace for the SiNx capping layer of the AlOx, resulting in no further annealing equipment being required.

Through working with tier-1 customers in China, SolayTec says that it has developed a track record in turning a standard Al-BSF line into a PERC line within three months, delivering a total efficiency gain of 1% on mono c-Si. The company reports that for this upgrade only one additional laser is required. SolayTec works with established equipment vendors to deliver a comprehensive PERC solution.

Belgium's imec research group has achieved 22% efficiency for a large area N-PERT using SolayTec's ALD tool. The company says results such as these will accelerate the roll of n-type PERT solar cells, demonstrating that high conversion efficiencies can be achieved with the next generation of double-sided c-Si cells.



SoLayTec reports its Spatial ALD machines for deposition of ALD Al_2O_3 can be applied in the processing sequence of PERC solar cells, as well as other next generation solar cells like n-type PERT solar cells and interdigitated back contact (IBC) solar cells.

3 X3 solar cell stringer

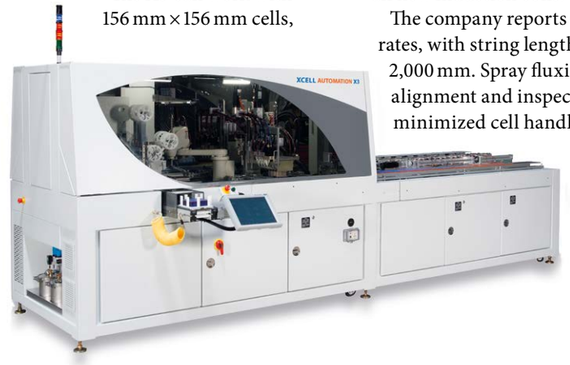
U.S.-based Xcell Automation is a new name to PV production, however it's a familiar company, being the result of a management buyout of the former Komax Solar. Its latest generation stringer, the X3, can connect 1,800 cells/hour for an annual throughput of 51 – 58 MW. It applies its patented Continuous Stringing technology.

The X3 can work with 156 mm × 156 mm cells, 78 mm × 156 mm half cells, and 125 mm × 125 mm cells.

The number of busbars with which the X3 works has been expanded, so it can apply a two, three, four, or five busbar configuration.

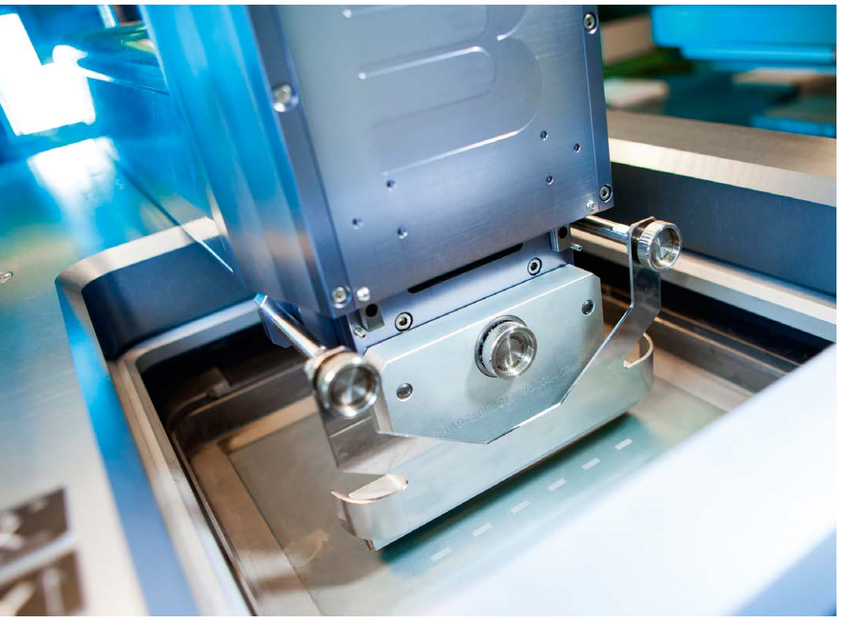
Xcell Automation claims that the 3rd generation Closed Loop Induction soldering technology results in increased processing speeds, through enhanced temperature reading and accuracy, and all new induction coils.

The company reports 0.2% breakage rates, with string lengths of up to 2,000 mm. Spray fluxing, optimal alignment and inspection, and minimized cell handling through a streamlined Accu-Track system are also touted as advantages delivered by the X3.



4 Mono 2D patterning and boron doping technology from Applied Materials

With the PV industry being driven by a 10 watt per year 'efficiency clock', cell manufacturers need to innovate and upgrade their technology at a rapid pace to improve efficiencies. N-type monocrystalline wafers, which have been decreasing in cost, produce higher efficiencies than multicrystalline wafers and are not impacted by light induced degradation (LID). Applied Materials is enabling this transition with its implant technology and advanced screen printing solutions, the Solion XP and Esatto.



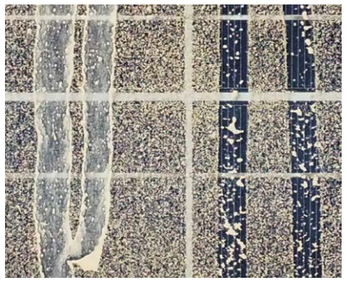
Offering unique in-situ 2D patterning and boron doping capability, Applied Materials claims the Solion XP Ion Implant System is the industry's only high efficiency, high yield, and high throughput implant solution. This ability to form precise junctions enables the production of n-type mono cells with more than 21% efficiency. Adopted worldwide by PV manufacturers for producing n-type cells, the Solion XP is a proven low cost per watt solution for cell and module manufacturing.

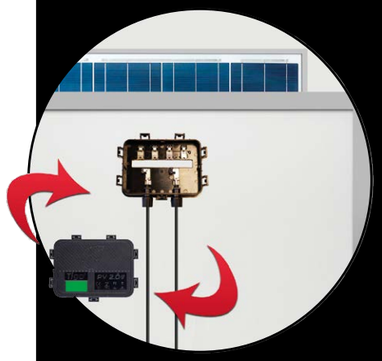
Providing tight printing alignment and precision, Applied's Esatto Technology for Fine Line Double Print has been shown to further improve cell efficiency by 0.2% and to reduce silver paste usage by > 10%. Available on a 2× higher throughput platform, Applied says it sets a new standard for productivity and low cost at the highest cell efficiency performance.

5 CleanARC Coating by Enki Technology

U.S. startup Enki Technology is now offering its CleanARC coating material, which has exceptional durability and built-in anti-soiling functionality.

The material's intrinsic water repellency and high durability make CleanARC coated modules an ideal choice for project sites with harsh environmental conditions such as sea mist, high humidity, and extreme temperature fluctuations. Its smooth, homogeneous structure and hydrophobic properties bind dirt less firmly – enabling more effective self-cleaning than traditional coatings. CleanARC coating is also less prone to abrasion wear from regularly scheduled cleaning.





6 Tigo's TS4 increases its addressable market

U.S. Module Level Power Electronics (MLPE) supplier Tigo has released its TS4 platform. While well established in the MLPE space, Tigo believes that the TS4 will allow the company to provide module manufacturers and installers with a greater degree of flexibility in supplying their end customers.

The TS4 baseplate provides a single interface, allowing it to be coupled with five different electronic covers, for a range of end user needs and budgets. In short, with one baseplate the Tigo TS4 can be coupled with five different power electronic configurations. Cover options range from a standard diode baseplate through to fully optimized performance and safety features.

Tigo says its TS4 platform is also upgradable, to remain flexible as end user needs change.



7 New modular system for CIGS buffer layer deposition

German equipment supplier Singulus Technologies is unveiling a new chemical buffer layer deposition for the production of CIS or CIGS thin film modules. It says that CIS/CIGS technology is at the vanguard of PV technology.

Singulus says its completely new generation of the Tenuis II system provides a cost-effective solution for the crucial chemical buffer layer component of thin film production.

Tenuis tools represent a modular cluster system, which enables savings in terms of floor space, allowing for the simultaneous coating of one side of two substrates. This and other benefits of the Tenuis II, Singulus says, delivers cost advantages for CIS/CIGS manufacturing.

The new system allows manufacturers to replace the more common cadmium sulfide and zinc oxide intermediate layers with zinc oxide sulfide and zinc magnesium.

Singulus reports cost reductions through process-adjusted temperatures and efficient use of chemicals. Singulus offers a range of wet processing systems, from R&D and pilot lines up to 60 MW, 150 MW, and 300 MW lines.

8 ALD buffer layer deposition for CIGS from Avaco

Korea's Avaco has tackled the challenge of buffer deposition utilizing atomic layer deposition (ALD) technology. Avaco's new technique provides precise Cd-free Zn(O,S) deposition.

Avaco reports that its ALD technology is superior to conventional chemical bath deposition for the buffer layer as it removes the risk of Cd pollution and because it is a dry process, it is more conducive to in-line manufacturing.

The Avaco ALD tooling can be applied to 600 × 1,200 mm substrates, with ±2% temperature uniformity. The company claims these results have been confirmed with CIGS manufacturers currently in production. As CIGS recipes may vary, the tool supplier says it can cater the deposition and process to meet a range of specifications. The deposition layer performs at a comparable level to a Cds buffer, coupled with the benefit of a dry process.



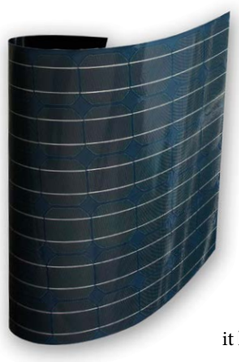
Technology Highlights

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Thin CIGS from Midsummer

After reaching CIGS aperture efficiencies of 17%, Sweden's Midsummer is currently turning its attention to active layer thickness, to continue to drive down costs. Over the past 12 months, Midsummer reports that it has reduced the thickness of its CIGS layer by 50%.



Late last year Midsummer announced that it had achieved a CIGS layer deposition of as little as 800 nm, while achieving an efficiency of 16.7% on a 156 mm square cell.

Midsummer supplies a 5 MW DUO tool, which can be used for unbroken vacuum deposition of cadmium-free CIGS, using a sputtered process. Midsummer's ramp concept is to add several DUO tools in parallel.

A stainless steel substrate is used for the Midsummer deposition prcess, with cells being punched out of a stainless roll, before being tabbed and stringed in a similar fashion to a c-Si cell.

Flexible and lightweight modules are a key application targeted by Midsummer for its customers. Midsummer has developed both its hardware and CIGS processes in-house and its service program is aimed at bringing the customer to market in the shortest possible time.

Midsummer recently provided modules to one of Sweden's biggest live music and sport venues, the new Tele2 Arena in Stockholm.

10

Two-step laminator delivers throughput for glass-glass

China's Jinchen Machinery is delivering its JCCY 2336-T two-step laminator for glass-glass module and flex module encapsulation. It's two-step process involves a first chamber in which the laminate is heated in a light vacuum and a second chamber where the lamination process takes place.



The JCCY 2336-T allows for the vacuum and temperature to be controlled separately. Jinchen reports that the two-step process increases throughput as the actual working time per chamber is reduced. This has an additional benefit in that the lifetime of consumable accessories is extended.

Jinchen makes the ambitious claim that the annual production of the two-step system is almost double that of a single-chamber system. The company says the floor space needed for the tool, including infeed and out-feed tables has also been reduced.

11

Spire launches new sun simulator

U.S.-based Spire Corporation has recently expanded its portfolio of sun simulators with Spi-Sun Simulator™ 5100SLP. The newest addition to the SLP series can handle modules with maximum dimensions of 2,100 × 1,400 mm. In an effort to reduce the cost of ownership Spire has designed the machine with just one lamp. Yet Spire claims that it is able to exceed IEC 60904-9 Class AAA specifications for irradiance spectrum, spatial uniformity, and temporal stability. Though Spire has introduced ts 5100SLP in March 2015, it will officially launch the machine during the SNEC.



Spire adds that the new system provides better than Class A irradiance from 400 to 1,100 nm, which replicates true sunlight conditions. The pulse duration of the light source is 10 to > 40 ms at 1,000 W/m². The irradiance temporal stability and the irradiance spatial uniformity are ≤ 0.2% at 1,000 W/m² and ≤ 1% respectively. Spire puts the lamp life at greater than 100,000 flashes. The sun simulator is capable of simulating intensities between 200 and 1,100 W/m² and can test modules with a maximum power of 600 W. The cycle time of the machine is 30 seconds.

Spire puts the repeatability at better than 0.15% as a result of a better control of the uncertainty. Spire has priced the 5100SLP at $140,000.

12



Silicor cuts solar silicon costs

California-based Silicor Materials has developed its solar silicon to deliver consistent purity and performance on par with traditional polysilicon, at roughly half the production cost of standard methods. The company's proprietary process uses aluminum to naturally draw the impurities from metallurgical grade silicon – a closed-loop process that requires two thirds less energy and yields salable aluminum-based byproducts.

Additionally, by eliminating the use of toxic chemicals common to traditional purification methods, Silicor's process is the most environmentally friendly in the industry.

Silicor is currently building its first commercial-scale manufacturing facility in Grundartangi, Iceland.

13 Measuring temperature coefficients with Berger

Berger Lichttechnik is introducing an environmental chamber to determine temperature coefficients of modules. Many companies claim advantageous hot weather performance, and now hard data from the Berger tool can be used to back it up.

The modular unit determines the temperature coefficients of PV modules according to IEC 61215/61646. In combination with a Multiple Filter Unit also available as an option the system can also be used for PV module performance testing and energy rating according to IEC 61853-1.



Berger says the tool is easy to install.

The chamber has a temperature range from ambient temperature to more than 80°C and can be increased to start below 15°C by adding an optional cooling module. In both cases temperature uniformity is better than 0.8°C on the PV module.

The main advantages of this system are the small footprint (< 0.85 m²), the low power consumption (< 6 kW) at rapid temperature change (> 1.5°C/minute) and reduced time needed to determine the temperature coefficients.

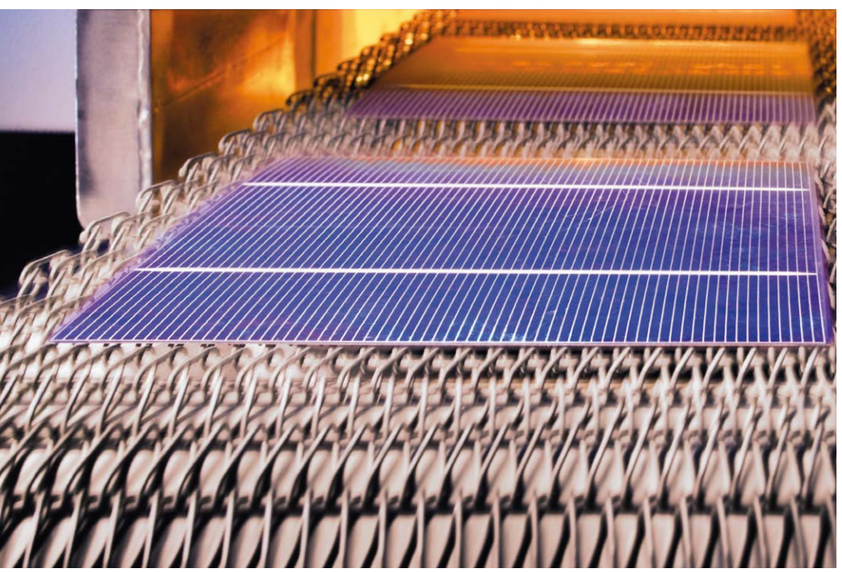
An eight channel thermocouple detection device is included to monitor and control the complete test run. The system is completely integrated into the BERGER test software, so the new functions are available with the same look and features.

The lead time for the environmental chamber is six to eight weeks.

14 New Solamet PV19x series and PERC materials

DuPont has released a new generation of its Solamet metallization pastes. DuPont's new high efficiency Solamet PV19x series has been unveiled along with new materials for PERC cell production.

The company is showcasing the new products along with its DuPont Tedlar PVF range in 13 leadership and technical forums at SNEC.





The presentations include:

- Improved accelerated test methods for PV solar panel service life prediction;
- Metallization related solar panel durability – a critical view of metal adhesion and its impact on solar panel term stability;
- Advanced materials help make solar panels more powerful – new front side silver metallizations;
- Study on snail trails formation and water ingression using accelerated aging; and
- Electrically conductive adhesives for PV applications.

A series of supporting poster presentations accompany the talks covering a range of themes under the Materials Matter banner.

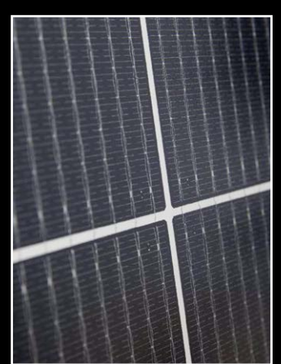
15 Schmid shipping its MBC technology

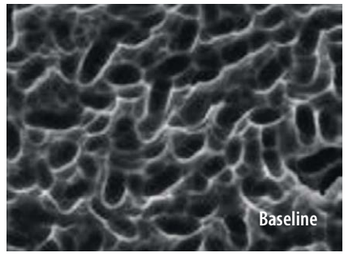
From three ribbons to 8 to 15 thin busbar wires: Germany's Schmid is reporting that it is receiving orders and shipping its Multi Busbar Connector (MBC) equipment.

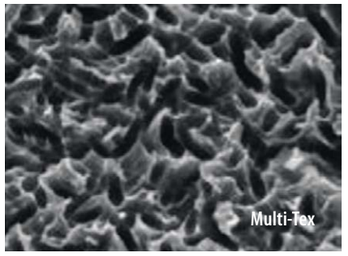
Schmid says that the technology delivers an efficiency boost through reducing shadowing, while saving silver – a key cost metric. The company says the MBC system uses a standardized soldering technology and standard materials.

High efficiency devices, such as bifacial modules can be connected by the MBC system. Schmid expects to receive return business on delivery of the MBC machines.









16 Multi texturing enters a new era

German's GP Solar Materials has launched its Mulit-Tex additive for acidic texturing processes. The company says that it delivers vastly improved surface structure, facilitating the rollout of technologies such as fast-growing multi PERC.

More than 10 cell manufacturers in Taiwan, Japan, and Singapore, under mass production conditions, have recently tested Multi-Tex. The results show that reflectivity of the textured wafer surface was by reduced by 20% compared to standard processes. As a result, cell currents Isc (up to +40mA) were boosted and cell efficiencies by up to 0.1% abs.

GP Solar Material's industrial partners also tested Multi-Tex on diamond wire cut (DMC) wafers. There have previously been challenges in texturing DMC wafers, however GP reports Multi-Tex met that challenge, increasing DWC cell efficiency by up to 0.27% abs.

The company reports that equipment manufacturers are facilitating the roll-out of acidic texturing with upgrade kits, including dosing systems for additives in existing wet benches.

17 Merlin's the word for GT Advanced Technologies

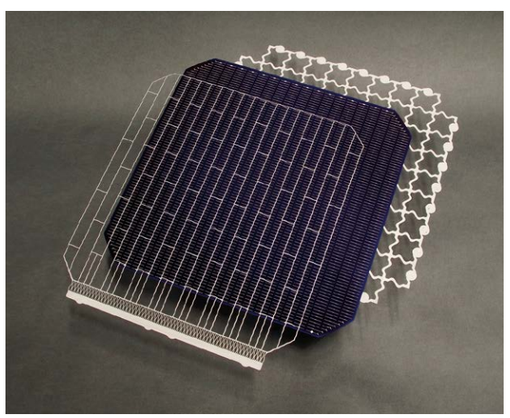
The last six months have been a difficult time for U.S.-based GT Advanced Technologies, however the company's Merlin Metallization and Interconnect technology holds serious promise.

GT reports that its Merlin flexible mesh can be attached to both the front and back sides of c-Si solar cells, both lowering the cost and improving the durability of modules. The company reports that Merlin can deliver a 10% reduction of total installed system cost, and up to 80% less silver delivering costs of $0.04/Wp at the module level, and boosting power per module by 3% to 5%.

GT Advanced also reports that new applications for PV can be opened up due to Merlin's lighter weight, with modules coming in up to 50% lighter than conventional modules.

Merlin's flexible grid connector tabs allow for maximum copper fill as needed to optimize current while increased durability and flexibility improves dynamic loading performance and reduces breakage during transportation and installation.

Market penetration of between 8% to 20% could be achieved by Merlin, according to GT.



Technology Highlights

18 Coveme introduces four dyMat PYE solutions

Italy's Coveme has released four new variations of its dyMat PYE PET-based backsheets, which meet a range of needs.

- High reflectivity: a new backsheet with increased reflectivity to enhance PV power output.
- Extra low shrinkage: special backsheet with reduced shrinkage level to fit extraordinary manufacturing requirements.
- 305 micron backsheet for UL Type 1: increased thickness to meet the new UL Type 1 requirements.
- Super extra thick version 1500 VDC: extremely thick backsheets able to reach more than 1500 VDC for maximum electrical insulation and special system requirements.

Through introducing the new range Coveme plans to expand on its claim of accounting for 30% of market share in the PET-based backsheet segment. The company emphasizes that its dyMat®PYE range is fluoropolymer-free and therefore suitable for recycling, an issue clearly growing in importance in the global PV market.

Coveme says its dyMat range has a durability up to three times higher than international standard requirements.





19 High density POC13 from Tempress

New from Tempress is its High Density POC13 (HD POC13). The new design allows for POC13 processing of > 3,200 wafers per hour through a five-stack system.

Tempress has developed systems for controlling dopant level and uniformity of the emitter process. To increase throughput, Tempress has designed a five-stack system that can be loaded by a six-axis robot. The full HD POC13 load of 1,000 wafers can be completed in under 15 minutes.

To achieve the increased throughput, Tempress reports that it had to confront a number of key questions:

- How can batch size be increased while maintaining excellent process results?
- Can low pressure be safely employed in high volume production?
- Can wafers be produced at a reduced pitch, while preserving the atmospheric POC13 process?

Tempress believes its HD POC13 answers these questions while delivering optimized cell efficiency, excellent homogeneity at high emitter resistivity, low surface concentrations, low maintenance, and a throughput of > 3,200 wph. The company also states its tool has a small footprint and low energy consumption.

Tempress says its experience of running 25 GW of production tooling has gone into the design of the HD POC13.

20 Ultra-clear tempered 2mm glass for glass-glass modules

Belgian solar glass provider Ducatt has produced what it claims is the world's first ultra-clear tempered 2mm glass for solar applications that is available on a mass production scale.

Ducatt says thin double glass modules offer advantages because of their prolonged lifetime of over 30 years; more flexible mounting options such as gluing on back rails and reduced optical transmission losses; and a reduced bill of materials.



The production processes for Ducatt's 2 mm ultra-clear and lightweight glass, glass rolling, and thermal toughening have been adapted for mass production. The company claims its 2 mm glass exhibits improved optical and mechanical properties that are ideal for glass-glass module application.



21 Light Trapping technology from DSM

Royal DSM N.V. is expanding its solar portfolio with a new "light trapping" film technology . This technology consists of an outdoor durable polymeric sheet that can be laminated onto the (glass) cover of a module. The polymeric sheet features a smart textured 3D structure, consisting of so-called "corner cubes." These are tiny cubes pointing upwards.

The cubes allow the light to enter the solar module, yet prevent the light from reflecting out of it. Effectively the light is trapped inside the module, resulting in greater energy production. Depending on the type, location and age of the module, DSM claims the additional energy can go up by approximately 6% to 12%. Light is also trapped effectively at low incident angles, which increases performance in morning and evening hours, as well as under cloudy sky conditions.

The film will first be brought to market as a retrofit solution targeting large existing PV parks. The modules in these parks could see a major power output boost as they often suffer from higher reflective losses. The secondary rollout will see it being applied to new PV systems.

DSM is currently evaluating the technology in a number of geographies with a broad range of industrial partners. The Dutch company is currently scaling up manufacturing technology in preparation for a worldwide product launch.

22 A+A+A+ LED cell tester

With a spectrum match in excess of 95%, Gsola claims its LED cell flasher can be used for testing on a range of c-Si cells and thin film solar cells. Its irradiance can be adjusted to simulate a range of geographical regions.

Pulse width on the tool ranges from 10 ms to 200 ms or more. Both IV and Sun-Voc functions are included and Gsola says that spectrum response can be measured in one second.



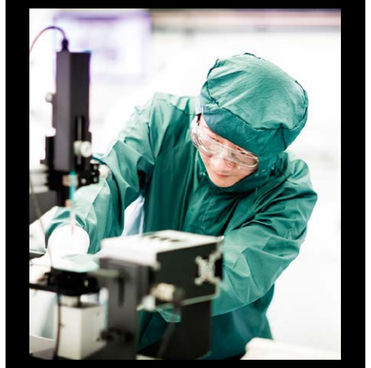
23 Perovskites to turbo charge PV

England's Oxford PV last month raised another round of equity finance to continue to commercialize and develop its pervoskite technology. The perovskite innovator raised $12 million from new and existing investors as it aims to realize tandem applications of its technology.

Oxford PV says perovskite is ideally suited to tandem applications as the parts of the solar spectrum perovskite harvests is particularly energy rich and is largely differentiated from that which traditional PV materials convert to energy.

The company says that 28% conversion efficiencies are possible with perovskite in a tandem application. The material can be applied with standard glass coating equipment. Oxford says the monolithic perovskite efficiency it has achieved stands at 17%.

Oxford PV formed as a spin off from Oxford University in 2010.





24 RENA relaunches with new wet chemical tool for PERC

Germany's RENA has released its InOxSide+ wet chemical tool and process for edge isolation and integrated rear side smoothing and cleaning. The tool facilitates PERC cell processing.

RENA Technology has attracted a new strategic investor in Capvis, from Switzerland, and the firm indicates it will increase its focus in the wet chemical processing field.

The InOxSide+ tool can achieve etch depths of up to 6 µm, in a process that can be tailored to customer needs. RENA says its innovations also deliver perfect front side emitter protection with the tool.

RENA says that with a new investor in its corner, the company is set to enter a new growth phase. Production equipment of high efficiency cells will remain its core competency.

"A new company name with long-standing experience and know-how," is RENA's key message in 2015.



25 LED flashing moving forward

Germany's Wavelabs continues to report shipments of its LED Solar Simulator technology, with shipments to Asia and leading PV labs.

Wavelabs employs light-emitting diodes. An innovative optical lens system and auto-calibration eliminate the weaknesses of current solar simulators and create new characterization techniques in production and R&D.

Wavelabs shipped its first LED-based solar simulator in 2013. The company reports that this and subsequently shipped products are still running with the first set of LEDs, regardless of whether they are running in 24/7 production or R&D.

German research institute Fraunhofer ISE, one of Wavelabs' customers, has recently confirmed the high quality of the spectrum delivered by the technology during final acceptance tests. The maximum deviation from the standard spectrum is below 1% (class A++++).

Wavelabs believes that the combination of reduced running costs and higher quality based on its special implementation of LED technology for solar simulation creates a significant benefit for its customers.
Jsun International is Wavelabs' official sales and service partner for China.





26 Coextruded backsheets for superior aging performance

Chemical developer and supplier Evonik is continuing to build data that it believes demonstrate how Vestamid-based coextruded backsheets can deliver superior aging performance, particularly in humid climates or agricultural applications.

Vestamid PA12 is a long chain polyamide that has been used in highly demanding applications since its invention in 1964. The performance advantages compared to traditional laminated or coated backsheets, claims Evonik, are due to the innovative structure by the advanced coextrusion process without PET core and without adhesives. These components are sensitive to UV, moisture and oxygen as well as other chemicals.

Evonik reports that besides the superior module protection, these backsheets boost the module performance by a higher reflectivity, increasing module efficiency as well as decreasing water vapor transmission and removing corrosive acetic acid.

Due to the production process, coextruded backsheets can easily be adjusted to e.g. 1,500 V applications. Vestamid PA12-based coextruded backsheets are fluoride free.

New Crosslinker for EVA Encapsulants

Evonik has developed a new crosslinking system for EVA encapsulants. With this new crosslinker customers will have the opportunity to minimize PID risk significantly and achieve cost savings compared with polyolefines, without forfeiting the favorable properties of EVA.

27 Evasa presents second generation PID free encapsulants

Higher electrical resistivity – even in extreme conditions such as high temperatures and high humidity levels – is the promise given by Evasa for its second generation EVA encapsulants.

The company claims its PID free generation of products has a volumetric resistivity of around 1,015 ohm·cm and is chemically enhanced for lower humidity absorption. An additional advantage is the shorter cycle processing offered by the product.

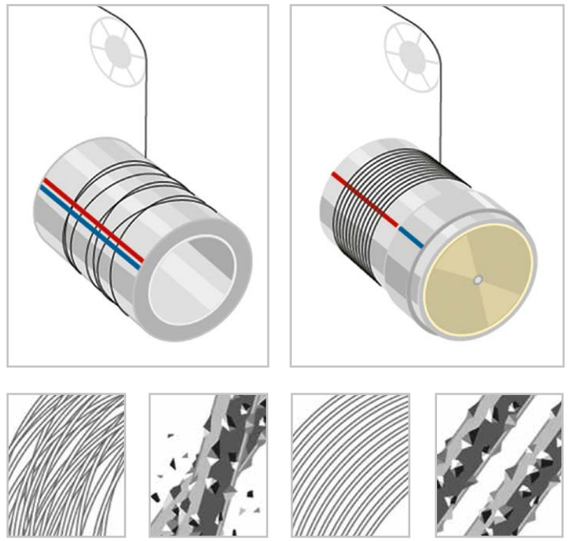
Evasa says its new encapsulants have passed IEC 62804 standard tests, showing strong resistance to PID. After testing the modules for 96 hours at 60ºC and 85% humidity by applying a potential of 1000 V, the tested modules recorded total power losses of less than 2%.

The new generation of encapsulants include a "solar total transmission" and PID free + STT version, which exhibits lower UV blocking – allowing for the entire solar spectrum to reach the PV cell.

	New 2nd generation PID free encapsulant	New 2nd generation PID free STT encapsulant
UV cut-off (nm)	360 nm	280 nm
Light transmission (%)	> 91	> 91
Volume resistivity (Ωcm)	> 1,015	> 1,015
Shrinkage (%)	< 1	< 1
Gel content (%)	> 80	> 80
Adhesion to glass (N/cm)	> 85	> 85

The Spanish company also uses additives to prevent yellowing or polymer degradation.



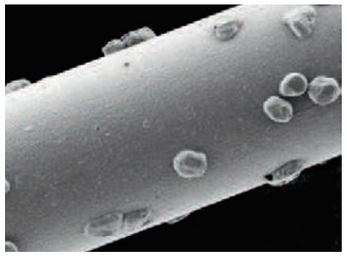


28 Meyer Burger to manage diamond wires

Swiss technology supplier Meyer Burger launched its Diamond Wire Management System (DWMS) in late 2014. It is a winding system that has been specially designed for Meyer Burger diamond wire saws.

During cutting, the wire is wound and unwound on spools on each side of the wire web.

The innovative DWMS design separates the spool into a supplier (storage) part and a working part. On the working part, the wire is wound in non-overlapping windings with a minimal pitch. This completely eliminates wire-to-wire contact, thus maintaining wire sharpness and extending the life of the wire.



29 Fast JB bonding with Sika's latest SikaMelt

High initial strength, fast cooling and reduced material usage are all qualities of the latest generation of SikaMelt on the market. The Switzerland-based company has released its SikaMelt-9185 IA hotmelt adhesive that it claims will save both cost and production time.

SikaMelt-9185 IA can be applied at a temperature of +160°C. Fast cooling delivers initial handling strength and curing with ambient moisture delivers a durable elastomer, which cannot be subsequently melted, the company claims.

Sika says modules can be processed immediately after application with process steps involving elevated buffer zones. Modules can be rotated for flashing or stacked vertically immediately after bonding of the junction box, delivering time savings.



30 Production equipment approved for cell cutting

InnoLas has announced that its ILM-2 laser platform has been approved for cell cutting, qualifying the tool for the production of half cells – a growing area of solar manufacturing due to reduced cell-to-module efficiency losses. The German supplier has begun shipping the tool to manufacturers.



With a cell cutting throughput of 8,000 cells per hour running in 24/7 production, InnoLas reports that the ILM-2 can be installed as part of an in-line production or alternatively as a standalone tool – when equipped with the InnoLas high speed automaton system.

Along with the production of half cells, an area a number of major manufacturers are currently investigating, the ILM-2 can be employed for laser contact opening for PERC production, laser fire contacts, and also laser contact opening for plating processes.

Multiple laser sources can be integrated into the ILM-2 platform.

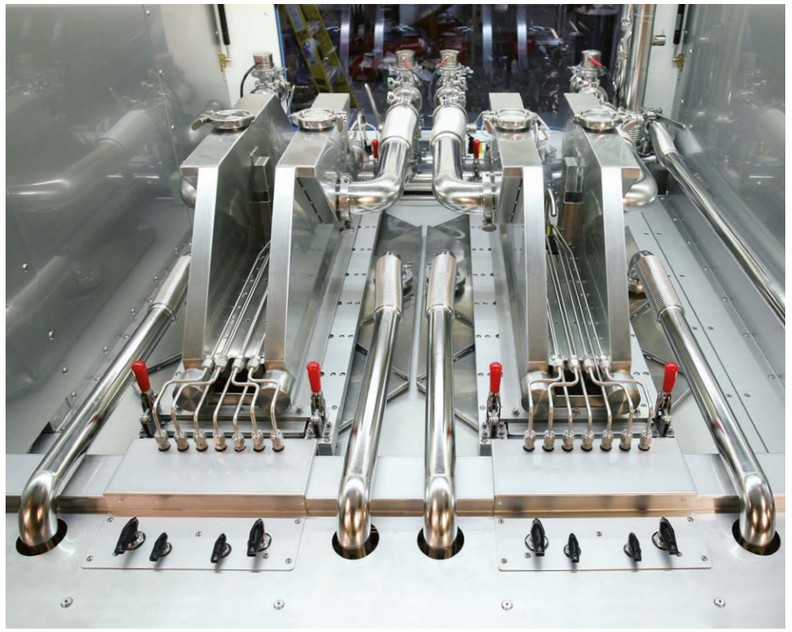


31 Meyer Burger rolling out its MAiA platform

In March technology provider Meyer Burger announced that it was supplying SolarWorld with its MAiA platform for MB PERC upgrades for around 400 MW of production equipment.

The company says that its MAiA 2.1 system platform offers solar cell manufacturers the opportunity to significantly increase the efficiency and quality of their existing solar cell production lines. It claims 21.4% mono PERC efficiencies have been achieved using the platform.

The maximization of gas utilization during the solar cell coating process and the positive influence on subsequent process steps enables MB PERC to deliver cost-saving potentials in a range of areas, says Meyer Burger. This includes a reduction of up to 30% in the use of expensive aluminum pastes for the solar cell contacting system.



32 PERC upgrades driving Schmid APCVD shipments

Schmid has begun shipments of its atmospheric pressure chemical vapor deposition (APCVD) tooling. In February the company announced that it was shipping eight systems to Asian manufacturers.

The APCVD tool is designed to apply doped glasses such as BSG and PSG and capping layers like SiO_2, which Schmid reports can be carried out on the tool in a single system. This is due to the tool's multiple injection heads. Co-diffusion can also be carried out on the tool.

Schmid says the shipments of its APCVD tooling indicates that a clear trend towards high efficiency cell concepts is underway, including the take-up of bifacial cell technology. The company reports it has been supplying APCVD tooling for more than a decade.

33 Small footprint stringer

Jinchen has released its JC.GF G060-2200 stringer that features fully automatic cell handling, loading and string unloading that can be integrated with external automation systems. The company says that its CCD-based visual system detects cell cracks, broken edges and scratches while monitoring the positioning of the bus bars.

The flexible ribbon press-holding system delivers low breakage rate and accurate soldering, the company claims.

IR soldering delivers moderate and smooth temperatures and Jinchen has integrated a patent pending flux application system with a < 1 mm nozzle to avoid overflow and control consumption.

A second visual system controls soldering accuracy and busbar coverage with an automatic inspection system replacing the manual alternative.

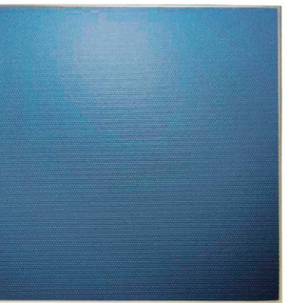


34 Borosil removes Antimony from solar glass

India's Borosil has tackled what it claims is solar's dirty little secret. The company is producing textured solar glass without antimony at its glass works in Gujarat, India. This product has a certificate of P1, which is the highest grading awarded by the SPF Laboratory in Rapperswil, Switzerland. It has also been certified antimony free by TÜV Rheinland.

The R&D team of Borosil worked on this project from 2010 to 2012, developing various melting mechanisms and carrying out trial melting at its laboratory. It then tested the products in-house and at third-party laboratories such as OMT, WUR of Netherlands, SPF of Rapperswil, and TÜV Rheinland, before finally commencing commercial production.

Borosil reports that India's ambitious solar plans alone, to install 100 GW of solar power by 2020, will mean 6,000,000 metric tons of modules will become defunct at some point in time.





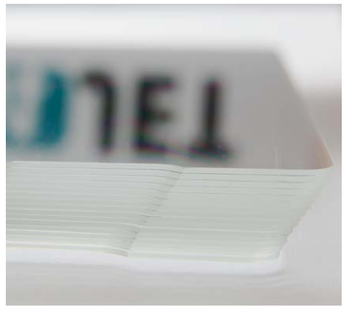
35 4Jet – touchless precision cutting

German laser system integrator 4Jet Technologies GmbH offers another solution for glass processing – PearlCut, which is also a touchless laser cutting process. The process uses ultrafast laser pulses and a unique beam shaping solution for controlled crack propagation in brittle materials.

4Jet claims that the new laser solution works non-ablative and kerf-free. As a result, no dust is created during the cutting process and the cut edges have a smoothness of Ra < 2 µm. The minimized edge defects result in the elimination of post cutting processes such as edge finishing.

4Jet notes that the PearlCut process recombines several well-known phenomena to induce micro modifications and self-focusing of laser radiation in glass by use of an ultrafast laser and a proprietary beam shaping solution.

4Jet's process is a compact system platform that allows processing of up to Gen 4.5 or two Gen 3 glasses. Though the loading is performed manually, by conveyors or cassette loaders, the system maps and corrects the panel position by CCD cameras ensuring an accuracy of +/– 20 µm.



36 Solar cell factory optimizer

Australia's BT Imaging has released the first iteration of its cloud-based solar factory simulator, which it claims is the first of its kind. BT Imaging is currently signing up users and conducting demonstrations at its "Solar Cell Factory Optimizer."

The combined soft and hardware system is initially targeted at training, reporting and marketing purposes, however BT Imaging says that subsequent versions will be able to be used for the virtual optimization of solar cell production lines.

The optimizer allows users to vary a range of operating conditions for PV production tools and BT Imaging's Photoluminescence Inspection equipment can be integrated into various stages of solar cell production to collect real world production data.

With the inspection equipment integrated into the optimizer program, the benefits of such equipment will become apparent because of its ability to make critical in-line decisions on sorting and rejecting production materials.

BT Imaging developed the Solar Cell Factory Optimizer in partnership with PV Lighthouse. It builds on aspects of the recently released PV Factory program.



37 Integrating IV+EL testing

Gsola has combined IV+EL testing for PV modules in one machine. The Chinese company reports that after loading the module and connecting cables, an operator can conduct both electrical property and micro defect testing – an IV and EL test, respectively. This, Gsola claims, can save space and conduct vital testing with a higher efficiency.

The integrated solar simulator is A+A+A+ class. The EL testing employs a 16.2 megapixel camera. The camera has been customized with German lensing and power supply and the software processing delivers a high quality image.





38 More than 100 LPKF systems running globally

LPKF has announced that more than 100 of its Allegro series of thin film scribing systems have been deployed globally. Key Allegro components, delivering internal accuracy while maintaining throughput peed according to LPKF, include the eight beam working head and beam splitting unit.

The Allegro series features eight beams in parallel that are focused onto the active thin film layer to be scribed. The head incorporates an axis to adjust focus and beam to beam distance without wear. It provides dynamic path tracking to minimize the dead zone across the panel and dynamic focus tracking to ensure scribe quality, even for warped substrates. Its internal camera system is used for inspection tasks and internal head calibration.

The second core component is the beam splitting unit. Depending on what pulse energy is demanded by the application and how much pulse energy can be delivered by the laser source, the beam splitting unit can be configured for 1:8, 2:8 or 4:8 beam splitting, thus minimizing costs. Each single beam can be attenuated to ensure homogeneous scribe quality across the panel.

Eight beam scribing and highly parallelized internal glass handling achieve cycle times below 30 seconds for a typical cell design on today's thin film glass substrates.

39 3D laser printing for c-Si cell contacting

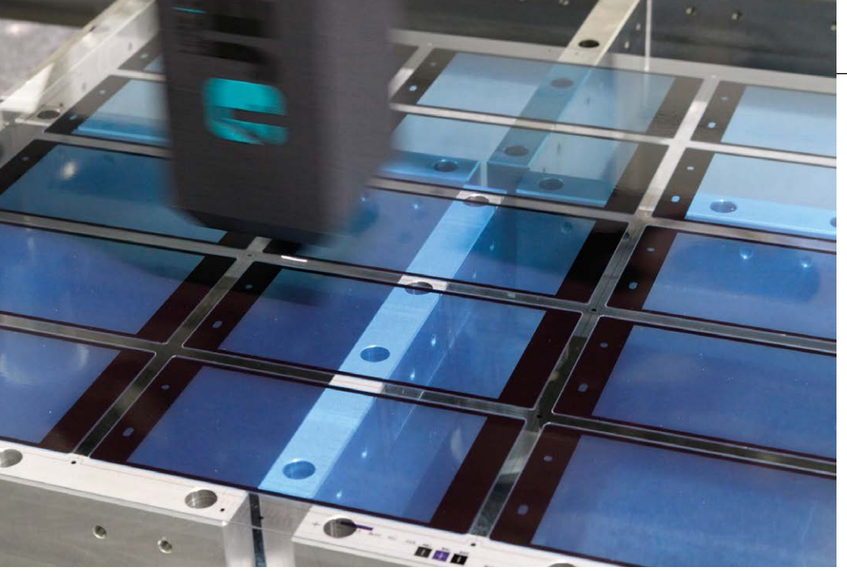
Israeli startup Utilight is introducing a non-contact 3D laser printing technology for contacting of c-Si cells. The process, which Utilight describes as novel and disruptive, results in contacts that are narrower and have a higher aspect ratio than traditional methods.

Utilight says that its 3D laser process can deliver a 0.4% absolute efficiency increase, with silver paste savings of as much as 50%. The company says the process is capable of double printing without the need for drying between prints.

The technology goes by the name of Pattern Transfer Printing (PTP) and results in a narrow outline. It is suitable for high throughput manufacturing and can be retrofitted to existing lines.

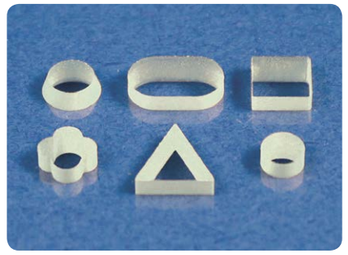
Utilight reports that 130 finger lines can be printed onto a cell in 0.8 seconds.





40 4Jet's drilling solution for glass-glass modules

Germany-based 4Jet Technologies GmbH has launched GDSflex, which it believes is a cost efficient and flexible solution for glass-glass module manufacturing. The new product is for drilling holes in glass substrates for c-Si photovoltaic modules.



The company notes that the increasing levels of production of glass-glass requires holes to be created for bus-bar wires and junction boxes in cover or substrate glass sheets. The tool allows drilling of several holes in different locations depending on the module design. The GDSflex systems allow in-line processing of glass panels in a fully automated and highly flexible setup. 4Jet notes that holes of different diameter can be positioned in any quantity anywhere on the glass sheet without retooling. Further, the machine is designed to work with typical glass module sizes and thicknesses.

The company notes that as opposed to conventional mechanical processes, laser drilling provides for a touchless and dry process. It adds that regular float and semi-tempered glass can be processed with the 4Jet system. The company also offers solutions for high precision drilling and cutting of chemically strengthened low thickness glass used in glass-glass modules.

41 High throughput table flasher and LED-based UV and IR-response cell retrofits

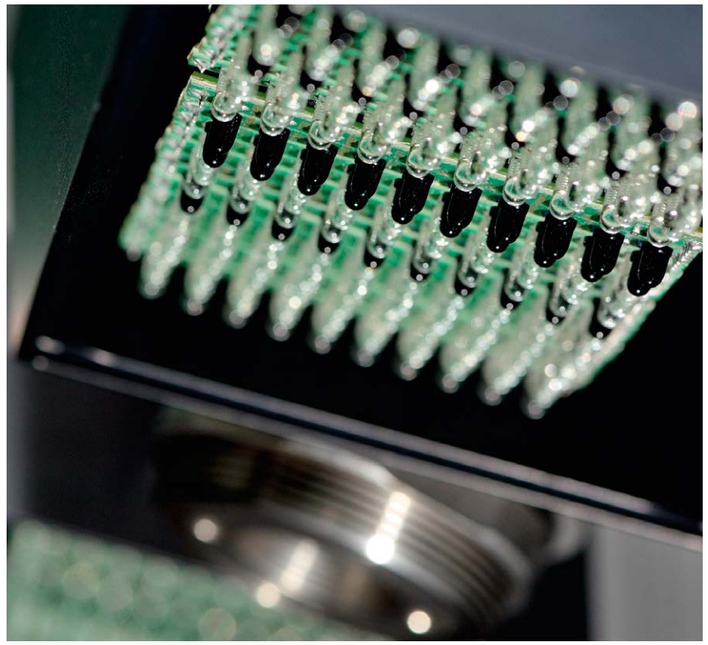
In two additional innovations the team at Halm have brought new solutions to the module and cell production market. The products are the cetisPV-Moduletest-Flat1 and cetisPV-cell-InlineSR.

The cetisPV-Moduletest-Flat1 is a compact, high throughput table flasher Halm says is ideal for high volume module production.

The cetisPV-cell-InlineSR employs LED-based UV and IR-response measurements. It is available as a retrofit on all Halm cell testers.

Additionally Halm is introducing a new system to facilitate IV-curve measurement of busbarless cells. Halm's new system involves a modification of the probe bars, crucial for IV-curve measurement, which can be retrofitted to existing testers.

Halm says its new system for busbarless measurement causes no bowing of the cell, allowing easy retrofit. The company is confident that as busbarless cells become more common in the market its new probe solution can meet the growing demand in a cost effective fashion.



CIGS*fab*

manz
passion for efficiency



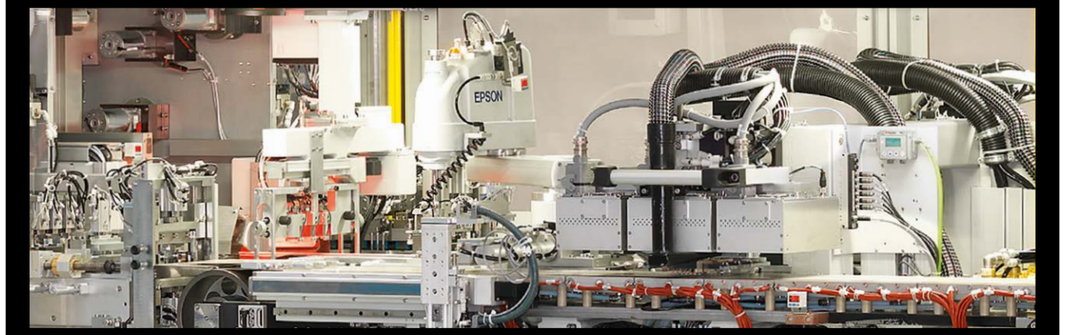
With an **IRR of >15 %**, the Manz CIGS*fab* is currently one of the most profitable investment opportunities on the energy market.

By investing in our fully integrated turnkey production line for CIGS thin-film solar modules you can achieve **lowest cost of energy** and thus **maximize your profit**.

Visionary thinking and entrepreneurial spirit have helped so many technologies to make a breakthrough. **In the energy market it is now time for the solar CIGS revolution!** Don't miss your chance to be part of it!

Learn more about the business model

www.manz.com



42 1,800 cells/hour with the GTS18

Spain's Mondragon Assembly has released its latest tabber and stringer system. Claiming it to be the world's fastest, Mondragon reports a net output of 1,800 cells an hour.

Mondragon's GTS18 employs infrared soldering in a simple and modular machine, that the company says is robust, flexible and ergonomic. The GTS18's cell loading automation is the broadest available, according to Mondragon.

Features of the GTS18 include visual cell positioning for avoiding contact and therefore breakages; flux dispensing without contacting the cell; and an anti-camber systems to ensure alignment.

Mondragon says that the system can operate under a range of process configurations, allowing a range of materials and processing parameters to be used. A range of cell and module types can be accommodated by the GTS18, with minimal changeover time.

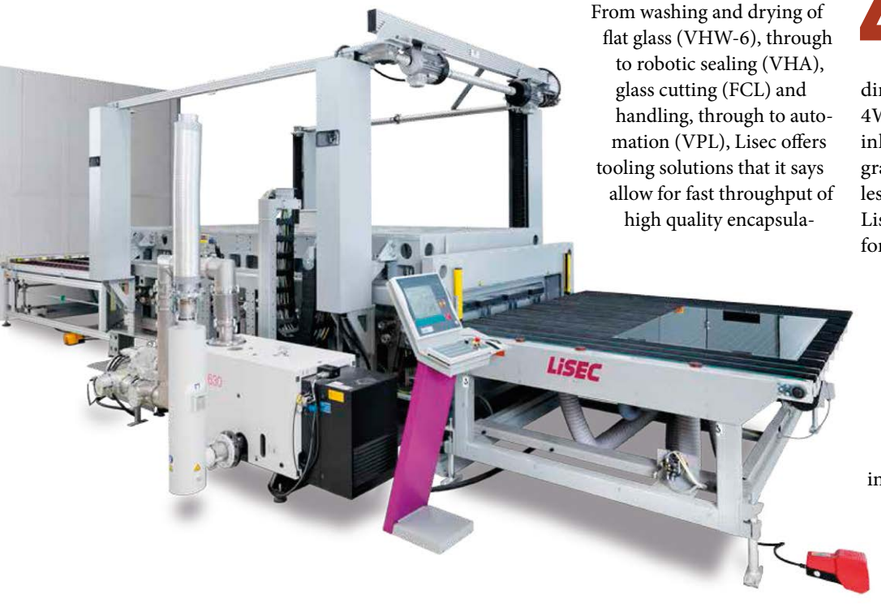
The dimensions of the GTS18 tabber and stringer are 5,900 × 2,000 × 2,100 mm (W × L × H) and it weighs in at 4,200 kg.

The power consumed is 26 kW/hour, and the installed power is 70 kW. It operates with an air consumption of 1200 Nl/minute.

43 Lisec's solutions for solar-meets-glass

Austrian glass processing equipment supplier Lisec offers a complete glass-glass encapsulation process for module assembly. Glass-glass modules are a growing segment within PV module manufacturing and Lisec supports their development with a range of tooling currently on the market.

From washing and drying of flat glass (VHW-6), through to robotic sealing (VHA), glass cutting (FCL) and handling, through to automation (VPL), Lisec offers tooling solutions that it says allow for fast throughput of high quality encapsulation. Its vacuum laminator is suitable for a range of encapsulation films and can seal delicate solar cells without displacement while forming a hermetic seal.



44 MEM4WIN: future PV windows

Taking PV glass innovation in new directions, Lisec is driving the MEM-4WIN project, which will allow for ink-jet printed OPV to be fully integrated into quadruple glazed, frameless openable windows.

Lisec aims to reduce fabrication costs for the 'windows for the future' by replacing cost-intensive materials like ITO and silver with graphene and through developing high-throughput production methods for anti-reflective coatings and the encapsulation of moisture-sensitive films such as OPV.

Five university and six additional industry partners are participating in the MEM4WIN project, which is funded by the EU.

47 Heraeus SOL9631 R&D Series

The Heraeus Photovoltaics Global Business Unit will be introducing its SOL9631 Series of front side metallization paste before the end of the third quarter 2015. It is presenting the technology for the first time at SNEC.

Leveraging its co-ownership of the Shoei Chemical Inc. patents TWI453930 and TWI432539, Heraeus' new series of pastes, incorporating lead free tellurium glass frit, has demonstrated greater than 0.1% cell efficiency gains due to reduced contact resistance; higher fill factor; and higher open circuit voltage relative to current commercially available pastes.

Along with an increased adhesion of 1 newton, the SOL9631 Series also has shown excellent aged adhesion.

Over the next several months, Heraeus will optimize the SOL9631 R&D Series for alpha customers and convert new customers to the commercialized version of this high performance paste.

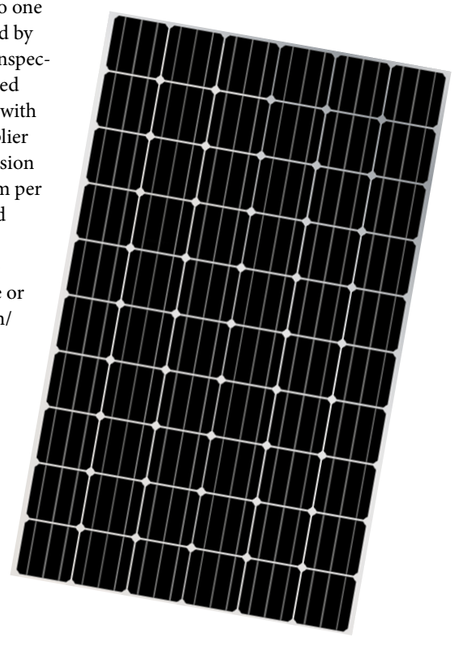


48 New generation of cameras from Isra Vision/GP Solar

Higher throughputs of up to one module/second can be delivered by the new generation of camera inspection technology being introduced by Isra Vision/GP Solar. Along with enhanced throughput, the supplier reports that high resolution version of the equipment, of of < 100 µm per pixel, can help deliver enhanced defect classification.

Regardless of whether it processes a cell or string, either pre or post-lamination, the Isra Vision/GP Solar products CELL-Q, STRING-Q and MOD-Q are ready to support the solar industry in its efforts to improve yield, quality and performance values in production, the company reports.

The technology applied is electroluminescence inspection as well as visual inspection featuring the company's well-known color inspection performance that has been applied in over 1,000 installed solar cell inspection systems worldwide.







46 Sveck takes on Snail Track problem

Changzhou Sveck's latest generation of PID technology is aimed at protecting against the phenomenon of power degradation through the formation of snail tracks. Sveck's SV-15296P and SV-15297P EVA are anti PID and offer protection against snail tracks, the company reports.

To combat the formation of snail tracks, Svev says that its focus on high quality materials is the key to the avoidance of snail tracks. It says that the use of scrap or recycled materials can be responsible for snail track formation, with the uniformity of the EVA being compromised, allowing for micro-cracks to form.

Sveck reports that up to 40% of solar modules installed in Western China displayed evidence of snail tracks within nine months of installation. It says that the problem can occur in a wide range of climatic conditions including Southern China, Southeast Asia, and Japan. Most often snail track formation is observed about five or six years after module installation.

45 Vertical processing for 20.5% PERC cells



Manz has continued to progress the technology driving its VCS 1200 vertical vacuum coating system for the deposition of dielectric passivation layers on the rear of solar cells. The tool takes a different approach to PERC upgrades.

The German company says that its unique vertical coating process offers a range of advantages, and that the tool is able to be easily added to existing production lines to provide a PERC upgrade.

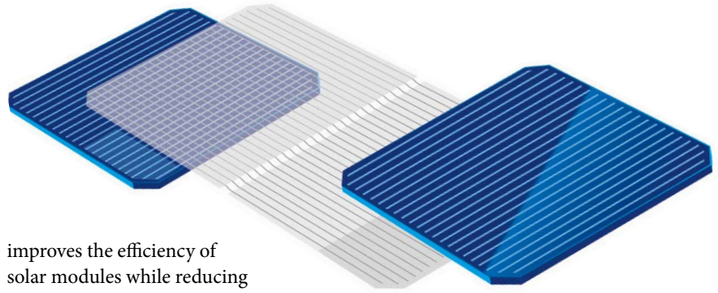
The VCS tool's name comes from its throughput of 1,200 wafers/hour.

Manz reports its new carrier system has the advantage of leaving no pin marks or flakes on the wafers. The vertical process also allows single-sided deposition of PECVD layers without wrap around of deposition onto the other side.

Cleaning of the process chamber is quick, says Manz, due to a quick change concept allowing for the process chamber and carriers to be cleaned outside of the tool itself. Manz claims the industry's lowest cost of ownership for front and back side coating.

Along with the VCS 1,200 tool, at SNEC Manz is showing its complementary LAS 2,400 laser ablation system for the opening of rear side passivation layers, and its IPSG CEI 4,800 wet chemical tool that removes the highly doped layer from the rear and edges of wafers.

49 SmartWire to wave bye-bye with busbars



Having landed its first SmartWire Connection Technology (SWCT) supply deal in mid 2014, Meyer Burger is continuing to roll out the technology.

The Swiss company claims that SWCT is the most cost effective method of connecting cells. Meyer Burger acquired the core SWCT technology from Day4 Energy and has since been investing in its development.

Employing a wire-foil electrode instead of the conventional cell connectors (ribbons), Meyer Burger says SWCT improves the efficiency of solar modules while reducing production costs.

The dense contact matrix and the resulting lower shading significantly enhances solar module performance, while the elimination of the busbars on both sides of the cell combined with the optimization of the finger widths reduces the amount of silver required by up to 80%.

50 For the first this year pv magazine is partnering with SNEC for SNEC Executive Club

For the first time this year, **pv magazine** is partnering with SNEC to deliver two unique experiences at the show. The SNEC Executive Clubs (located in halls W3 and E3) provide a space for solar executives to network away from the noise and bustle of the trade room floor.

A series of CEO interviews will be held in the Executive Clubs, where leading solar media professionals will be given the opportunity to interview leading international and Chinese solar CEOs.

Wavelabs and InnoLas are the Gold Sponsors of the SNEC Executive Club.

"The emphasis is on efficiency levels"



Photo: Klaus Dombrowsky/Austrade

Interview: Considered by some to be the father of modern photovoltaics, Professor Martin Green, from the University of New South Wales, spoke to pv magazine about the PV module and cell trends featuring in this special Technology Highlights download.

pv magazine: How would you sum up where the PV industry is at the moment from a technology basis, of new technologies coming out onto the market and into production?

Martin Green: It seems to me a transition is taking place with many of the leading companies now switching from the standard back-surface field kind of processing approach to the passivated emitter rear cell (PERC). Things are starting to happen there finally. We always felt that things had to happen there eventually but it has taken a while.

Monocrystalline PERC seemed to be the first stage of PERC rollout, but it seems that multicrystalline PERC is now being adopted pretty quickly into production. Is that also what you are seeing?

I was amazed at the recent Trina Solar result where it was able to achieve 20.8% conversion efficiency with a multcrystalline silicon PERC cell. That is better than what we have been able to achieve in the laboratory, regardless of how many stops we pull out!

I guess the multicrystalline is improving so eventually it will be able to get pretty much the same performance as monocrystalline, so it has been gaining on the monocrystalline. Mono has been pretty much stationary in terms of the performance you can get from it while the multi is improving year after year. So eventually the gap will get narrower and narrower.

I think that multicrystalline PERC will eventually achieve something like 25% efficiency on the cell level.

There are a number of production processes and pieces of production equipment that can be employed in PERC production. What is your take on what are the best solutions for PERC upgrades?

It seems that eventually everyone will come to a common opinion as to what the best technique is. It is very early days and it is probably going to take a while for everyone to work out on which is the one that should be concentrated. But I think that is the nature of the industry: The best solution gets identified and the whole industry zeros in on it eventually. With time I think it will become clear.

The plasma-assisted processes are the ones that have dominated for the antireflection coating but I don't know whether that will happen for the rear dielectrics as well, as it could be something else.

Some manufacturers are also turning to bifacial modules. What do you make of developments there?

Bifacial modules are nearly in competition with PERC technology because a lot of the performance for PERC comes from the good reflective properties of the rear of the cell. So it is approaching competition with bifacial cells.

Bifaciality makes sense because extra energy can be collected but to me it doesn't seem to be a big attraction on the market. The extra performance that can be achieved doesn't seem to have pushed manufacturers towards bifaciality.

What are next-level cell technologies that pique your interest?

I think cells have to go tandem, as the step after PERC gets perfected. That again is in conflict with bifaciality, because it just doesn't apply to tandem cells. Bifaciality might be a technology that gets bypassed if we can get tandems working fast enough. The logical progression is the tandem approach and PERC is very well suited to tandems because it is getting as much red response from the silicon cell as possible.

And what tandem combination are you most excited about?

We're hoping that we can make perovskites on silicon work because they are just about perfect in terms of their band gap and the voltage that you can get out them. Perovskites do have lead in them but not much more lead that is being used in solders at the moment, so that is not a real killer at the moment. But it's the stability of perovskites that is the real challenge at the moment as they are not really robust. The big question is whether the instability will always be the case. If it wasn't for the instability of the material, it would be a perfect match for silicon and it would be a very clear choice. ◆

Interview by Jonathan Gifford