PERC EUS

Production Package for PERC Solar Cells
PERCEUS
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PERC
The next generation solar cell with an efficiency of more than 20 %.
SINGULUS TECHNOLOGIES
Developer, Enabler and Supplier for the PV Market

SINGULUS TECHNOLOGIES is a supplier of manufacturing solutions and production equipment for the markets Optical Disc, Semiconductor, and Solar. With new machine concepts and manufacturing processes in the crystalline and thin-film solar technology, SINGULUS TECHNOLOGIES establishes itself as development partner and equipment supplier for investments in new high-performance solar cell concepts. As market leader for Optical Disc production systems we have gained extensive know-how in vacuum coating, automation, and process integration.

SINGULUS TECHNOLOGIES cooperates with cell manufacturers worldwide and develops processes, which improve the efficiency of solar cells and at the same time reduce production costs.

Evolutionary improvement in cell concepts like PERC or PERT, n-type material, IBC cell or heterojunction cells will drive the future of crystalline solar cells.

Production of PERC Solar Cells

→ Single side polish etch with LINEA II
→ Rear side passivation with SINGULAR XP
→ PERCEUS Production Package for PERC solar cells

Other process applications improving cell performance

→ Complete production lines – SOLARE
→ ICP-PECVD coating equipment – SINGULAR
→ IPA-free wet process equipment – SILEX
→ LINEA II parasitic emitter etching and edge isolation
→ LINEA II isotexture or PSG removal
→ Wet process equipment for poly silicon chunk etching, cleaning & drying – MATERIA
→ Low-cost and high-efficient cleaning process [Upgrade SILEX with Ozone]

PERCEUS
The Solution to Optimize your Profit

PERC (Passivated Emitter and Rear Cell) is currently the only industrially, economically justifiable cell power increasing technology that meets the requirements for a good balance between manufacturing costs [US$/W] and efficiency, thus securing interesting payback periods for the investment.

SINGULUS presents PERCEUS, a new production solution for rear side passivated silicon solar cell. PERCEUS was developed to upgrade existing cell production lines to manufacture PERC-type silicon solar cells (PERC – Passivated Emitter and Rear Cells).

SINGULUS TECHNOLOGIES offers additional process steps for the production upgrade PERCEUS.

→ A wet-chemical process step polishes the rear side of the cell using a LINEA II Single Side Polish Etch.
→ The dielectric passivation layer on the rear of the solar cell, consisting of a layer stack of ICP-AlOx and SiNx, is coated by the ICP-PECVD production tool SINGULAR XP.
→ For the final step, the rear contact formation done by Laser Contact Opening (LCO), SINGULUS TECHNOLOGIES is cooperating closely with partners.

With the integration of these additional production steps into existing production lines, PERC cells with efficiencies over 20 % can be made.

In March 2012, the Institute for Solar Energy Research Hameln (ISFH) increased the conversion efficiency of screen-printed silicon solar cells in cooperation with SINGULUS from today’s industry typical 18.5 % to a record value of 20.1 %. This was also confirmed by an independent measurement from the photovoltaics calibration laboratory of the Fraunhofer ISE (CalLab).

An improved cell rear side with an ICP-AlOx/SiNy double layer [ICP: „inductively coupled plasma“] enables this progress without „selective emitter“ technology. 20.1 % is one of the highest efficiencies worldwide reported for industrial type silicon solar cells with screen-printed metallization.
Evolutionary improvement in cell concepts like PERC or PERT, n-type material, IBC cell or heterojunction cells will drive the future of crystalline solar cells.

Standard silicon solar cells have a textured front and rear side. In order to optimize the light trapping within the cell and the conditions for a good rear side passivation with local contacts, a planar rear surface is most suitable. The differently structured front and rear surfaces of the wafer make the implementation of a single side etching process step essential. For the market of silicon solar cells, SINGULUS presents a new production solution for rear side passivated silicon solar cells (e.g. PERC – Passivated Emitter and Rear Cell). This solution was developed especially for the upgrade of existing cell production lines. For the upgrade of a production line, three additional production steps, which SINGULUS offers solutions for, are required.

Before coating the rear side is smoothed with a wet-chemical polish in a LINEA II Single Side Polish Etch machine.

The dielectric passivation layer is emitted in the ICP-PECVD machine SINGULAR. For the rear side contacts through a laser process, SINGULUS is closely cooperating with a partner.

**Main Characteristics**

- **Rear Polishing:**
  - Increase of internal reflection
  - Reduction of surface defects
  - Reduction of recombination centres
  - Longer carrier life time
  - Better passivation quality

- **Tool:**
  - Compact process stations with innovative organisation of media and process
  - Simple and robust „spider-chain“ wafer transport system with no mechanical contact on top side
  - Shadow free contact of the wafer surfaces with process media
  - Friction-free, gentle wafer transport through process media
  - Excellent accessibility of the process chamber from all sides by the separation process and installing modules
SINGULAR XP
Fully automated ICP-PECVD Production Platform for Rear Side Passivation

SINGULAR XP ICP-PECVD is a fully automated innovative and modular PECVD coating tool for the mass production of crystalline silicon solar cells. In addition, SINGULAR is increasingly being applied for the development of passivation layers for high-efficiency solar cells following conventional and new cell concepts. Thereby, the coating system meets the demands for both current and future PV cell production.

The SINGULAR system provides an automation module and a coating module. The coating module consists of several customizable vacuum chambers.

The innovative SINGULAR tool is based on static inline production which combines the advantages of inline substrate transport and static processing. It allows the coating of complex layers, such as layer stacks of different materials e.g. AlOx/SiNy. The key feature of the tool is the ICP-PECVD technology. The inductively coupled plasma (ICP) excitation allows ideal control of film properties for various materials such as SiNx, AlOx, SiOxNy at high deposition rates.

The process variability, the small tool footprint in combination with an excellent total "Cost Of Ownership", makes SINGULAR ideally suitable for upgrades of existing production lines. SINGULAR allows developing new manufacturing processes for cell efficiencies above 20 % on proven production platforms. Therewith, SINGULUS makes a valuable contribution to continuous improvements with respect to efficiency and manufacturing cost of PV modules, being a necessity to reduce the costs and enable the large-scale deployment of PV electricity.

SINGULAR – Facts

→ Industrial proven multi-chamber ICP-PECVD coating tool
→ Lowest cost of ownership
→ Modular design for various processes e.g. SiNx, SiOxNy, AlOx, a-Si …
→ Single- and multi-layer capability
→ Double-side coating capability
→ Small footprint
→ Integrated electrical and gas cabinets
→ Efficient use of raw materials like electrical power, process gasses …
→ Low noise level (no grey room necessary)
→ High uptime
→ Easy to operate
→ Easy to maintain
→ Inline cleaning processes available e.g. for a-Si
→ Customized tool configuration, e.g. usage of special gasses e.g. TMB, phosphine, organic precursors like TMAl
→ Integrated automation solution
→ Inline and cluster operation possible
→ All types of automation cassettes suitable