



#### FEATURES OF GENERIS PECVD

- » Throughput of up to 3000 / 6000 / 10000 M2 wafers per hour
- » Deposition of passivation, anti-reflective, insulation and protection layers
- » Typical processes: SiN<sub>x</sub>, SiO<sub>x</sub>, AlO<sub>x</sub>, a-Si, poly-Si, and plasma oxide
- » High-rate linear ICP sources
- » Dynamic deposition rates up to 120 nm\*m/min, depending on layer properties
- » Full temperature control before and during deposition
- » Typical substrate temperature 180 to 550 °C, for PERC 350 °C
- » Reliable horizontal substrate transport system with integrated carrier return system
- » Transport system out of vacuum, therefore no particle generation
- » Carriers for different substrate sizes (M2 to M12), typical wafer thickness 120 - 200 µm
- » Carrier with 64/80 wafers per carrier (M2 to M6), carrier material CFC
- » Automated wafer loading and unloading
- » Total coating width approx. 1.4 m
- » Layer uniformity < +/- 3 % on substrate and carrier-to-carrier



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#### SINGULUS TECHNOLOGIES - Thin-Film Coating and Surface Treatment

SINGULUS TECHNOLOGIES develops and assembles innovative machines and systems for efficient thin-film coating and surface treatment processes, which are used worldwide in the Photovoltaics, Semiconductor, Medical Technology, Packaging, Glass & Automotive as well as Battery & Hydrogen markets.

The company's core competencies include various processes of coating technology, surface treatment as well as wet-chemical and thermal production processes. SINGULUS TECHNOLOGIES sees sustainability as an opportunity to position itself with innovative products. In the focus are:

- » Environmental awareness
- » Efficient use of resources
- » Avoidance of unnecessary CO<sub>2</sub> pollution

SINGULUS TECHNOLOGIES attaches great importance to responsible and sustainable corporate governance.



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# GENERIS PECVD

Inline Plasma Enhanced  
Chemical Vapor Deposition  
(PECVD) System for AlO<sub>x</sub>  
and SiN<sub>x</sub> Passivation and  
Anti-Reflective Layers on  
PERC Solar Cells



# GENERIS PECVD

## Inline Plasma Enhanced Chemical Vapor Deposition System

### Vacuum Deposition Technology

SINGULUS TECHNOLOGIES has delivered more than 8,500 vacuum thin film deposition machines since its foundation in 1995. Their applications comprise standardized sputtering systems to specific ultra-high vacuum machines applying thin layers from angstrom to micrometer range for the semiconductor industry as well as for photovoltaics, data storage, decorative coatings and other applications. Plasma enhanced chemical vapor deposition (PECVD) has been utilized and continuously developed at SINGULUS TECHNOLOGIES for close to 20 years ranging from plasma source design to process and layer stack development for protective, optical and electronically active applications. Since 2007, SINGULUS TECHNOLOGIES has focused its PECVD development program to high-rate inline deposition of passivation, anti-reflective and semiconducting layers to enhance the efficiency of crystalline silicon photovoltaic cells.

SINGULUS TECHNOLOGIES employs inductively coupled plasma (ICP) sources for inline PECVD coating applications. ICP is a method that offers a high electron and activation density in conjunction with low ion energy, which allows very high deposition rates over a large width and extraordinary layer quality with wide process windows at low substrate damage. Therefore, ICP plasma sources are ideally suitable for high-rate and low-damage mass production of electronic devices like solar cells. SINGULUS TECHNOLOGIES has developed a new, large-scale linear plasma source based on this technology.

SINGULUS TECHNOLOGIES has already delivered a system for the deposition of functional layers for the production of gallium arsenide (GaAs) photovoltaic cells. The PECVD coating step is a crucial quality factor for GaAs solar cells that are renowned to achieve very high efficiency in excess of 35 % in multi-junction setup and that are used in space applications for the power generation of satellites.

### GENERIS PECVD

#### INLINE PECVD SYSTEM FOR $AlO_x$ AND $SiN_x$ DEPOSITION ON PERC SOLAR CELLS AS WELL AS A-SI / POLY-SI FOR TOPCON AND HJT

The newly developed GENERIS PECVD system is a modular horizontal inline tool designed for the special needs in mass production of state-of-the-art crystalline silicon solar cells with highest efficiencies, such as passivated emitter and rear cells (PERC/PERT) and cells with passivated contacts (e.g. TOPCon, POLO). PERC solar cells are coated on both sides with dielectric passivation layers. Rear side passivation is achieved by deposition of a thin aluminum oxide ( $AlO_x$ ) layer capped by hydrogen rich silicon nitride ( $SiN_x:H$ ). On the front side, a layer of  $SiN_x:H$  serves as both, passivation and anti-reflective coating (ARC). The system is ideally suited for cost effective mass production with high throughput, high uptime, short cleaning interruptions and maximum utilization of raw materials. The substrate temperature is fully controlled during the whole process, which enables optimum layer performance at temperatures in the order of 350 °C for PERC cells. The thermal properties can be adapted in a wide range for other layer stacks and applications. SINGULUS TECHNOLOGIES carriers allow single side deposition with close to zero wrap-around.

The GENERIS PECVD allows for deposition on both sides of the wafer without vacuum interruption. The application of both processes  $AlO_x$  and  $SiN_x$  is realized in one common system with help of a gas separation chamber. Thus, GENERIS PECVD can be configured to individual needs:

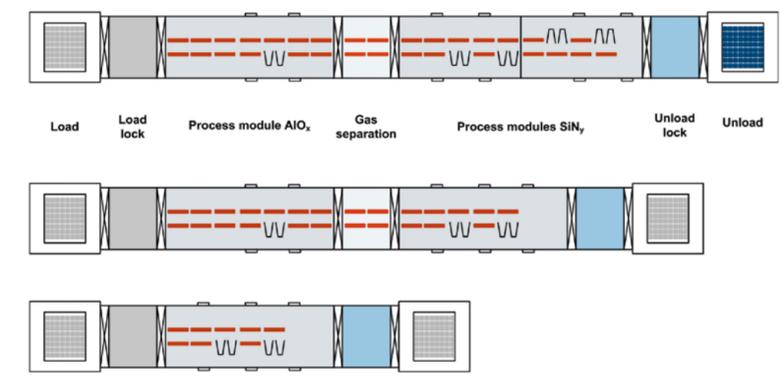
- »  $AlO_x + SiN_x$  on the rear and  $SiN_x$  on the front for complete passivation of PERC and other cell types
- »  $AlO_x + SiN_x$  for PERC rear side or n-PERT front side passivation
- »  $SiN_x$  on front and/or rear for anti-reflective or capping layer only
- »  $SiO_x$  or  $SiN_x$  as passivation and/or masking layers for interdigitated back contact cells (IBC) and comparable applications
- » Silicon and/or aluminum based oxidic or nitridic protection or intermediate layers for next generation and tandem cell structures

Especially the first configuration in which all PECVD layers are deposited in one tool represents a cost attractive, highly productive and straight forward production solution.

The system is using an inline process in which the substrates are transported on specially designed carriers for different wafer sizes. The carrier return system is located below the machine under clean environmental conditions. Different automation options for loading and unloading are available.

For the future, beyond the scope of silicon and aluminum based dielectric layers, GENERIS PECVD is already prepared for single-side deposition of doped amorphous and polycrystalline silicon layers for passivating contacts. High-rate inline deposition of these conductive semiconductor structures without wrap-around allows future industrial mass production of more advanced and ultra-high efficient cell architectures like TOPCon, POLO-BJ and tandem solar cells.

### GENERIS PECVD – PERC Configurations



**GENERIS PECVD**  
 Inline Plasma Enhanced Chemical Vapor Deposition System for  $AlO_x$  and  $SiN_x$  Passivation and Anti-Reflective Layers on PERC Solar Cells