



# GENERIS PVD

Inline Sputtering System  
for Heterojunction  
Solar Cells

# GENERIS PVD

## *Inline Sputtering System for Heterojunction Solar Cells*

### **Sputtering Competence**

SINGULUS TECHNOLOGIES has delivered far more than 8000 vacuum sputtering machines since its foundation in 1995. The machines range from standard sputtering systems to ultra-high vacuum deposition machines applying extremely thin layers of around 0.2 nm for the semiconductor industry as well as photovoltaic, data storage, decorative coatings and other applications.

In addition, vacuum thin-film technology is used in modern sensory technology for medical uses and in vehicle technology as well as for piezoelectric materials in mobile phone technology.

SINGULUS TECHNOLOGIES develops equipment and technologies for economical and resource-efficient production processes. The core competencies are vacuum thin-film technologies, wet-chemical processes, surface -and thermal processing technologies. SINGULUS TECHNOLOGIES taps new work areas with these competencies and develops innovative solutions.

For all processes and applications, SINGULUS TECHNOLOGIES uses its know-how in automation and process technologies as well as the integration of production steps and works on transferring these solutions to additional areas of application.

One main focus during the solar cell production is the efficiency. Heterojunction cell technology (HJT) achieves conversion efficiencies of more than 23 % as well as reduced manufacturing costs. The newly developed GENERIS PVD system is a horizontal inline sputter tool designed for the special requirements in photovoltaic high efficiency cell production.

Heterojunction cells are coated on both sides with transparent conductive oxide (TCO) layers by PVD (physical vapor deposition). The GENERIS PVD is ideally suited for challenging layer stacks i.e. TCO layers like ITO and AZO providing maximum optical transmittance, matched refractive index, optimum electrical conductivity as well as charge carrier mobility, which are key-parameters in heterojunction cell technology. Sputter damage to the amorphous silicon layer stack does not occur. A full substrate temperature control during the whole process enables optimum layer performance at temperatures  $\leq 200$  °C.

With the GENERIS PVD sputtering system, contact layers can be deposited on the front and rear of the Si wafers without the need to turn the wafers between coating processes and without vacuum interruption. Annealing of sputtered layers is integrated optionally.



GENERIS PVD

*Dedicated Inline  
Sputtering System for  
Heterojunction Solar Cells*

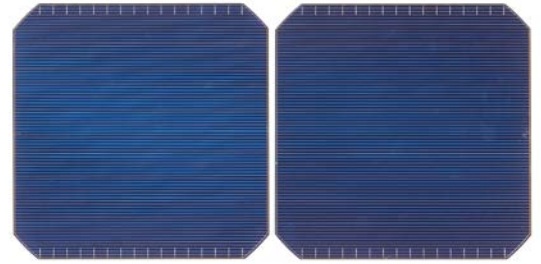
Also full area metal coatings, e.g. Ag can be deposited within the same system. By using rotatable sputtering magnetrons, highest target utilization is achieved and offers lowest production costs.

Other typical applications include anti-reflection layers, barrier layers and precursor layers but also different metallic layers such as Al, Cu, NiV, etc. The GENERIS PVD is using an inline process in which the substrates are transported on specially designed carriers, providing edge isolation simultaneously. The carrier return system is located below the machine under clean environmental conditions. Different automation options for loading and unloading are available.

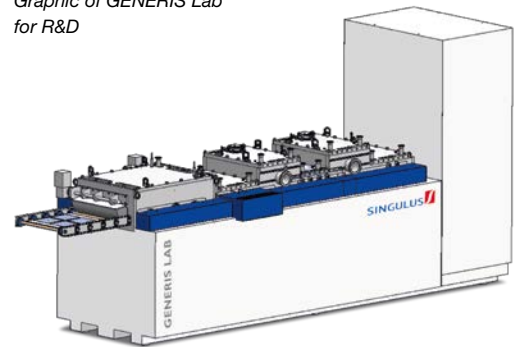
### Typical Performance Characteristics GENERIS PVD

- Sputtering materials: ITO, AZO and metals like Ag, NiV, Cu, Al etc.
- Parallel processing of several substrates (Si wafers)
- Available in 3 versions:
  - GENERIS LAB
  - GENERIS PVD 3000 for approx. 3000 wph
  - GENERIS PVD 6000 for approx. 6000 wph
- Modular configuration
- Low cost of ownership and high uptime
- Top down and bottom up sputtering configurable
- Sputter sequence configurable
- Full temperature control throughout the whole process
- Rotatable cylindrical magnetrons for highest utilization of target material
- Single end and double end version selectable
- Manual or semi-automated lab versions on request

Heterojunction Solar Cells Sputtered with ITO on GENERIS PVD

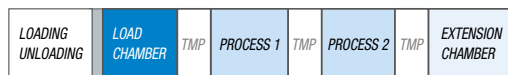


Graphic of GENERIS Lab for R&D

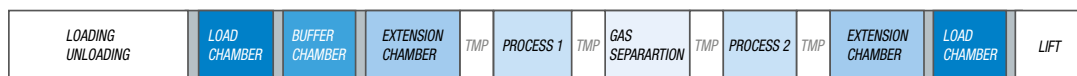


### The Modularity of the GENERIS PVD System Allows a High Degree of Flexibility

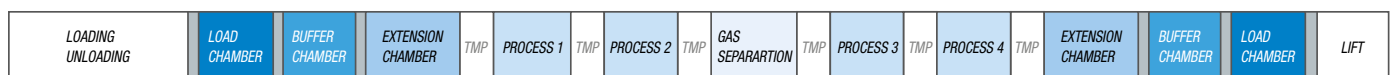
#### GENERIS Lab

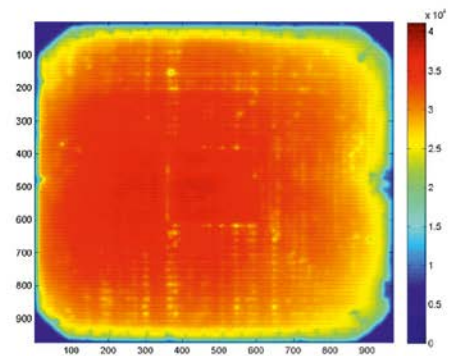
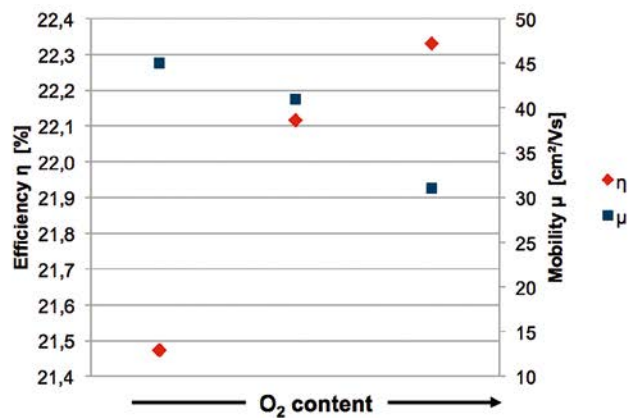


#### GENERIS PVD 3000

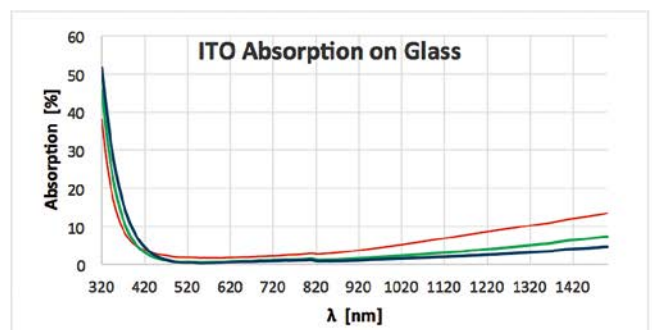


#### GENERIS PVD 6000





O₂ content	t [nm]	R <sub>sh</sub> [Ω□]	N [cm <sup>-3</sup> ]
Low	108	32	3.9 × 10 <sup>20</sup>
Medium	100	58	2.5 × 10 <sup>20</sup>
High	96	133	1.5 × 10 <sup>20</sup>



#### IV Data of Heterojunction Solar Cells Sputtered with ITO on GENERIS PVD

Lifetime [ms]	Impl. Voc [mV]	J <sub>sc</sub> [mA/cm²]	V <sub>oc</sub> [mV]	FF [%]	Efficiency [%]
4.0	736.2	38.3	736.9	79.13	22.33

Graphic of GENERIS PVD inline system with automatic carrier return for sputtering tasks in the production of Heterojunction solar cells



GENERIS PVD process chamber with top down and bottom up sputtering configuration



### Rotary Magnetrons with Intensive Cooling and Highest Material/Target Utilization

- Target utilization about 80 % for rotatable cathodes compared with only 30 % for planar cathodes
- More stable process with rotatable cathodes because of less nozzle formation
- Long-life rotary seals
- Maintenance on customers' site
- Advanced water fill and drain features
- Flexible target attachment method and non-proprietary target design



### GENERIS PVD

#### Technical Data

Application	Heterojunction solar cells
Cycle time	45 - 75 s/carrier depending on configuration
Carrier size	~ 1400 mm x 1200 mm 64 wafers per carrier, depending on wafer size
Throughput	3000 - 6000 wph, depending on configuration
Sputter material	ITO, AZO, Ag, NiV, Cu, Al, etc.
Sputter orientation	top down/bottom up
Vacuum base pressure	$1 \times 10^{-6}$ mbar
Typical process pressure	$2 - 5 \times 10^{-3}$ mbar



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THIN FILM  
DEPOSITION

SURFACE  
ENGINEERING

THERMAL  
PROCESSING

WET  
CHEMICAL

#### **SINGULUS TECHNOLOGIES – Innovations for New Technologies**

*SINGULUS TECHNOLOGIES develops and assembles innovative machines and systems for efficient and resource-saving production processes, which are used worldwide in the solar, semiconductor, medical technology, consumer goods and optical disc sectors.*

*The company's core competencies include various processes of coating technology, surface treatment and wet-chemical and thermal production processes.*