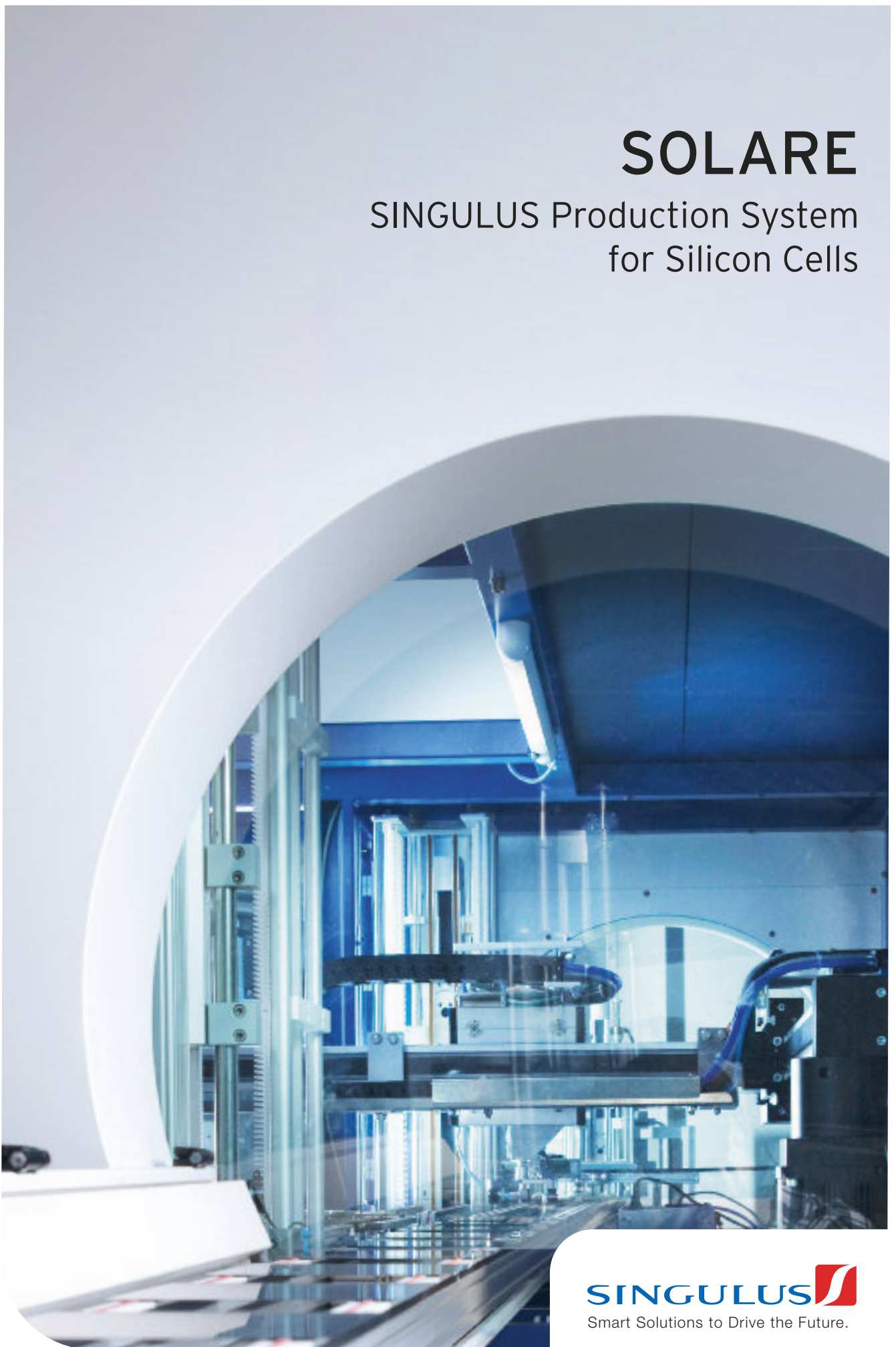


# SOLARE

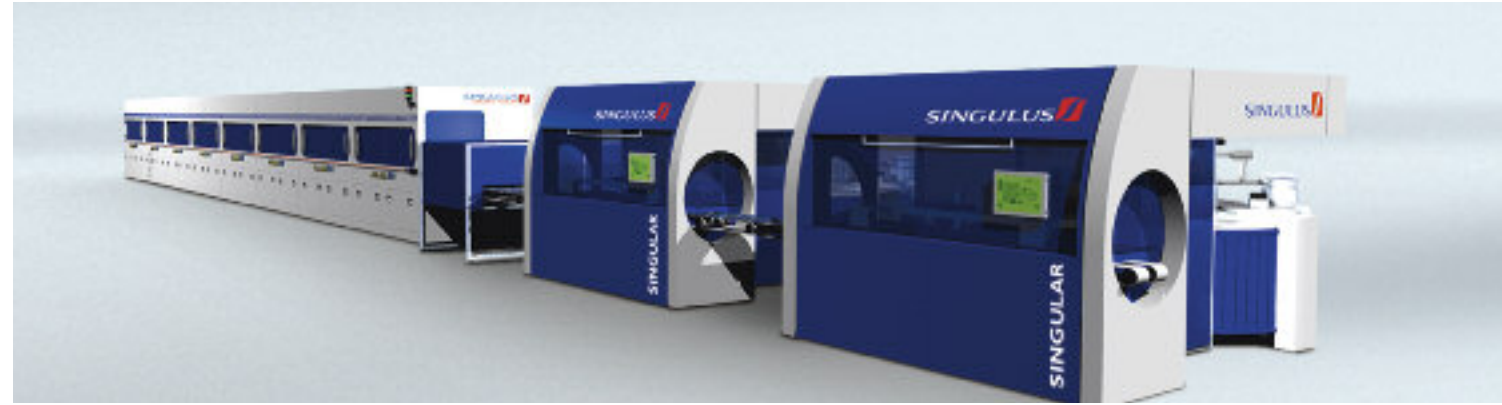
SINGULUS Production System  
for Silicon Cells



**SINGULUS** 

Smart Solutions to Drive the Future.

## SINGULUS System Business



SINGULUS TECHNOLOGIES Focuses on Photovoltaics:  
Smart Solutions for Silicon & Thin Film Solar Technology.

SINGULUS TECHNOLOGIES is the world market leader in manufacturing mass production equipment for Optical Discs CD/DVD/Blu-ray. With the acquisition of the solar company STANGL, the foundation was laid to establish SINGULUS in the photovoltaics market. Numerous new products were developed and made marketable at SINGULUS and SINGULUS STANGL SOLAR.

### Silicon Solar Technology – Transition from Machine Supplier to System Provider

The company's target is to position itself at the forefront for the introduction of new technologies with respect to silicon solar technology. SINGULUS will offer a broad product range of new machines for the photovoltaics industry, which will offer manufacturers of silicon cells new production technologies and therefore particular cost advantages. Especially during times of cost pressures in the photovoltaics market the interest regarding new plant concepts increases.

**Silicon Solar Technology**  
SINGULUS & STANGL provide completely automated solutions for polysilicon etching as well as treatment of Si wafers & cells in standard and high-efficiency production lines as well as AR coating systems for both current and future PV cell production.

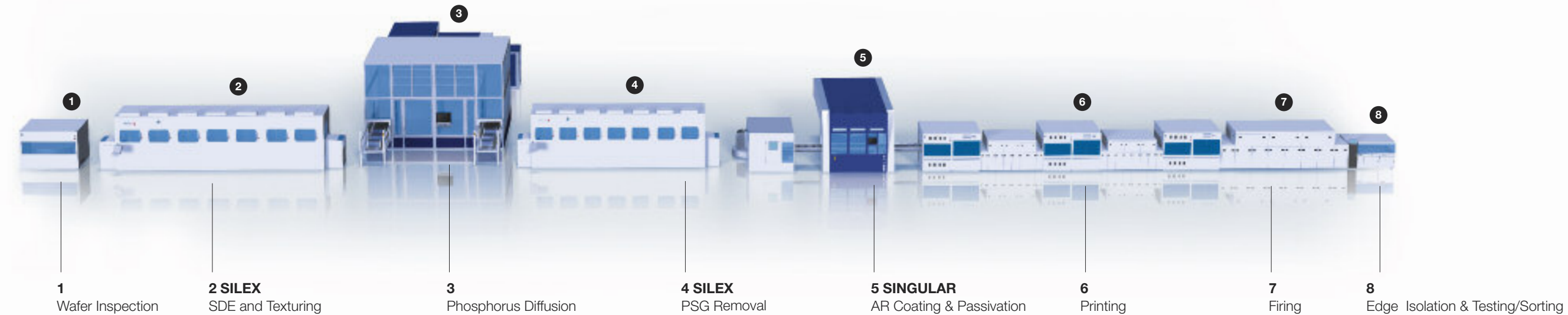
SINGULUS entered strategic partnerships to offer front-end technology for the production of silicon solar cells as a one-stop supplier as well as complete, integrated production systems. Such complete systems cover all individual production steps from the first cleaning process of the silicon wafer to the finished silicon solar cell. In the future SINGULUS will focus rigorously on the system activities with production equipment for solar cells and leverage the know-how of coating and automation technology, wet-chemical processes as well as system concepts.

Combined with STANGL's machines, SINGULUS TECHNOLOGIES offers the key-technology for a crystalline silicon solar cell production line with wet-chemical systems from STANGL for saw damage edge & texturisation as well as PSG removal and the SINGULUS vacuum coating and wafer handling technology. This enhancement of the business model from single machines towards systems was also successful in the Optical Disc market some years ago.

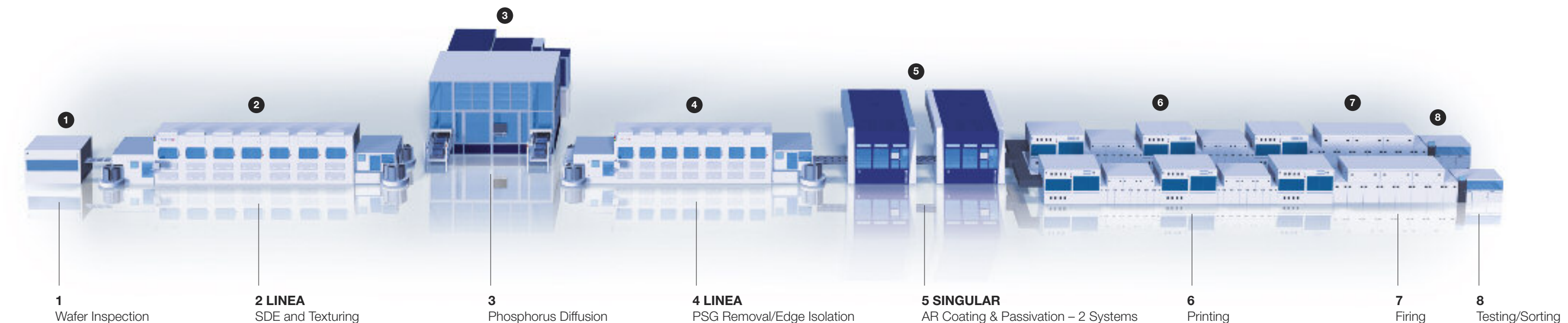
**SINGULUS TECHNOLOGIES is a**

- Specialist for special metallization processes utilizing the PECVD and PVD technology
- Specialist for inline process technology
- Provider of worldwide sales and service
- World market leader for Blu-ray disc and DVD/CD replication lines
- Manufacturer of molding machines and mastering systems

## SOLARE System for Batch Production of Silicon Cells



## SOLARE System for Inline Production of Silicon Cells



### SOLARE Production System

- 01 Wafer Stack Splitting, Loading/Inspection**  
Silicon solar cells are produced from raw wafers. After unloading from transport boxes, these wafers are tested to ensure that they have the right dimensions and weight and to check for any damage to the edges and surfaces. Good wafers are loaded into the system.
- 02 Saw Damage Etch (SDE) and Texturing**  
Batch-type wet benches (SILEX-series) are one choice for cleaning and either alkaline texturing of mono crystalline or acidic texturing of multi crystalline wafers. Another option is inline wet chemical processing of the cells with the LINEA machine from STANGL. In this process step any residue and saw damage is removed from the raw wafers and a light trapping structure (texture) is applied by wet chemical process. The etching and rinsing is done automatically in separate baths in an automatized sequence.
- 03 Junction Formation**  
Today's standard raw material is positively doped silicon (p-type). To generate the p-n junction, the wafers are doped with phosphorus. For this process, the substrates are loaded into Silicon Carbide process boats and are inserted into a tube furnace. Inside the furnace the wafers are exposed to a phosphorus containing gas ( $\text{POCl}_3$ ). At high temperatures of about 900 °C phosphorus atoms diffuse into the wafers. As a result a negatively doped surface layer is created.
- 04 Phosphor Silicate Glass Removal/ Edge Isolation**  
For this process step STANGL offers the SILEX batch and LINEA inline wet processing systems. The phosphorus silicate glass produced as a by-product of the diffusion process is removed in an acid bath. Additionally edge isolation can be realized with the LINEA inline system (PSG-EE).
- 05 SINGULAR – Static Inline Tool for High Uptime ICP-PECVD Anti Reflection Coatings**  
SINGULAR is a PECVD coating tool for passivation and anti reflection coating (ARC) for crystalline silicon solar cells. The tool offers an innovative static inline concept, which combines the advantages of static processing and inline substrate transport. During static processing, the substrates are not moved, therefore layer stacks and gradient layers are easily possible. Superior

# System Business

## Proprietary Know-How for Wet Processing and AR Coating



### WAFER HANDLING

Automated Loading, Unloading & Transfer System

### SILEX

Batch-Type Wet Process Equipment for c-Si Solar Cell Production

### LINEA

Inline Cleaning & Etching

### SINGULAR

Static Inline Tool for High Uptime ICP-PECVD Anti Reflection Coatings



passivation and optical properties can be applied. The fully automated inline cleaning process guarantees a high uptime of the tool for production. SINGULUS developed a proprietary, fully-automated wafer handling system for the integration and connection of the SINGULAR with the wet-chemical cleaning and etching equipment.

### 06/ Printing/Firing

**07** To extract the electrical power from the solar cell a silver paste contact grid is applied to the the front surface of cell by a screen printing process. This creates the characteristic grid pattern on the front of the cell. The back of the cell also receives two silver paste contact strips plus an aluminum layer known as the back surface field. This acts on the electrons as a kind of a mirror. The contacts are burnt into the cell in a hot furnace with around 900 °C. The high temperature causes the silver paste to penetrate into the silicon, thus forming a reliable electrical contact.

### 08 Testing/Sorting

Tested and classified PV cells need to be sorted and placed safely into storage or transportation boxes. For this purpose the sorter takes over the cells together with their identifier from the upstream testing machine. The cells are picked up by a vacuum suction cup and moved to the respective bins which are predefined by the testing and classification unit. Standard styrofoam boxes are used for taking up the cells. The basic machine allows for sorting into 16 classes. Optionally this may be extended to 32 or 48 classes.



## **SINGULAR**

Static Inline Tool for High Uptime  
ICP-PECVD Anti Reflection Coatings

SINGULAR is a new PECVD coating system for crystalline silicon solar cells, which should satisfy both today's and future requirements of solar cell production processes. The machine offers an innovative inline concept for powerful Si-solar cell production.



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SINGULUS 

SINGULUS   
STANGL SOLAR

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