Silicon Solar | Thin-Film Solar on Glass | Thin-Film Solar on Flexible Material

SINGULUS & STANGL

A Strong Player in Photovoltaics

STANGL

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SINGULUS & STANGL

A Strong Player in Silicon & Thin-Film Solar Technology. SINGULUS TECHNOLOGIES Focuses on Photovoltaics

Unlimited Solar Energy

The energy demand of the world's population is steadily increasing. However, the availability of oil, gas and coal is limited. Next to wind and bio power as well as the energy generation from water power, the use of solar energy through the direct conversion of sun light into electric power also plays a very important and future-oriented role.

With the entry into this technology SINGULUS TECHNOLOGIES will contribute to the conservation of our environment, but also participate in the emerging, lucrative business opportunities.

Solar Modules Soon Available as Mass Products

The globalization as well as the world-wide urbanization and industrialization are boosting the demand for energy. It is apparent that the use of up-to-date production technology and the efficient use of raw materials are important elements for cost reductions in the energy sector. In addition to the other renewable energies, in particular the photovoltaic sector will be able to make worthy contributions to solving these problems.

Due to new cell concepts with improved efficiency as well as significant cost reductions for so far scarce semi-finished materials and efficient production, the generation of solar power will become more and more economically viable. It is expected that by 2010, the cost for solar power will reach grid parity in countries with long and intensive sunshine. This will raise the demand for solar modules and in the end boost the build-up of production capacities for mass production.

SINGULUS TECHNOLOGIES Focuses on Photovoltaics

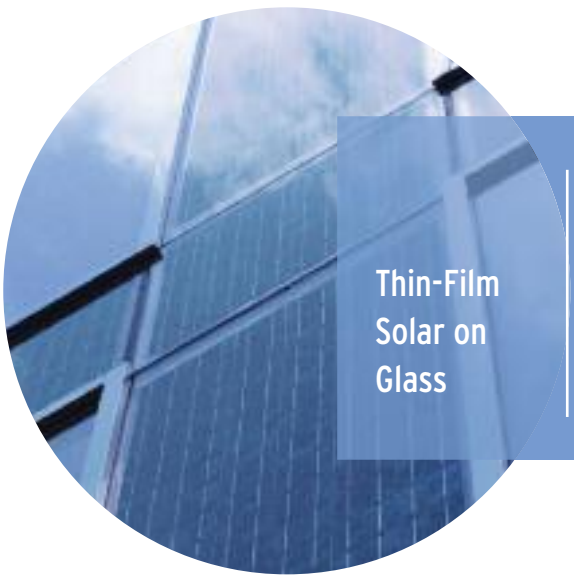
SINGULUS TECHNOLOGIES, the world leader in manufacturing mass production equipment for Optical Discs CD/DVD/ Blu-ray, has joined with STANGL to focus on the photovoltaic market.

While STANGL specializes in wet-chemical processes, SINGULUS' core competence is physical coating and atomization technology.

SINGULUS' extensive know-how is the optimal base for development of highly profitable, fully-automated production lines. SINGULUS and STANGL will each concentrate on their particular areas of expertise so that together they will be well-positioned to offer a broad range of products to the photovoltaic industry over the next few years.

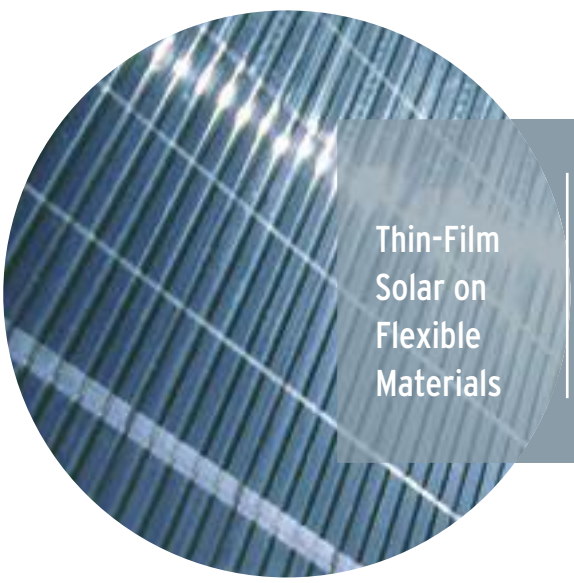
Silicon Solar Technology

Process Equipment for Silicon Solar Technology
Today´s dominating solar cell concept bases on cells made from crystalline silicon. STANGL provides completely automated solutions for poly silicon etching as well as treatment for Si wafers & cells in standard and high-efficiency production lines. SINGULUS has developed the new SINGULAR machine, a PECVD coating system which meets the demands for both current and future PV cell production.



Thin-Film Solar on Glass

Process Equipment for Photovoltaic Thin-Film Cells on Glass
Thin-Film cells based modules supply energy even at low light levels and high temperatures.
Low manufacturing costs of the CIS modules can only be achieved in mass production. STANGL designs and produces high-tech systems that are used for fully-automated application of the single-sided wet chemical CdS coating. Dry Process Equipment is ready for market introduction this year.



Thin-Film Solar on Flexible Materials

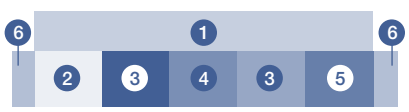
Process Equipment for Thin-Film Solar on Flexible Material
Thin-Film solar cells on flexible materials are on the advance due to their potential applications regarding low weight, high flexibility and low cost of manufacturing compared to silicon based solar cells

MATERIA PCE

Poly Silicon Chunk Etching, Cleaning & Drying

1 Installation area
2 Pre-washing
3 Rinse
4 Acidic etching
5 Dry
6 Input/output cart

MATERIA PCE



The MATERIA PCE is a batch system for chemical etching, cleaning, and drying of polysilicon chunks. The system is adapted to the high purity demand in polysilicon production. Simultaneously, lowest possible total cost of ownership has been a key driver in the development of this machine.

The MATERIA PCE is a fully automated system for high throughput industrial production. It relies strongly on the STANGL SILEX product line for cell fabrication which can look back on a world-wide installed base of over 80 machines.

Main Features

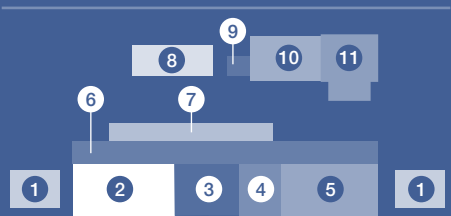
_ Proven, highly integrated design based on STANGL SILEX
_ For polysilicon (electronic, solar or UMG grade)
_ Chunk sizes between 20 and 180 mm
_ Throughput: from 500 - 2500 t/pa
_ Built for non-stop utilization: 24/7, 360 days/year
_ High availability (uptime > 95 %)
_ Compliance with international safety regulations
_ Flexible coupling to adjacent processes by cart transportation system

GERULUS

Wafer Block Pre-Clean & Deglue System

1 Transport cart
2 Input buffer
3 Pre clean-bath
4 Deglue chamber
5 Output buffer
6 Installation area
7 Waste water pump stations (optional)
8 Hot DI water station (optional)
9 Surfactant dosage
10 Dirt and pure water tanks
11 Centrifuge

GERULUS



Virtually all silicon based wafers are cutted by wire saw technology. The STANGL GERULUS Pre-clean & Deglue system processes the wafers after being cut. This includes removal of slurry as well as degluing the wafers from their carrier beam.

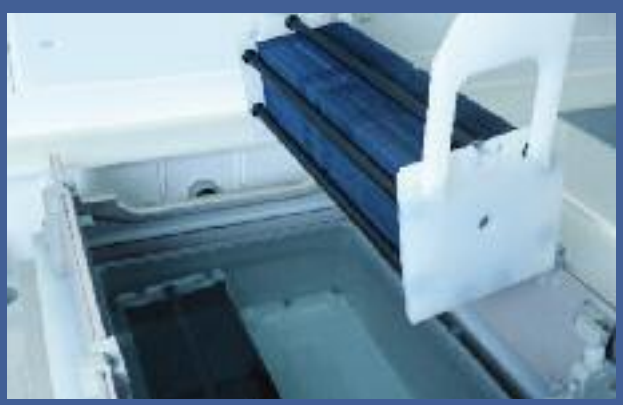
The GERULUS system can be configured in a wide range to adapt to all kinds of slurry and glue types. To guarantee lowest possible water and surfactant consumption, the system can beequipped with a water & SiC recycling system.

Main Features

_ Proven, highly integrated design
_ High throughput up to 7200 wph
_ Built for non-stop utilization: 24/7, 360 days/year
_ High availability (uptime > 95 %)
_ Sophisticated pre-cleaning concept for best process results and minimal process times
_ Compliance with international safety regulations

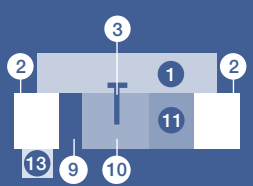
SILEX

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

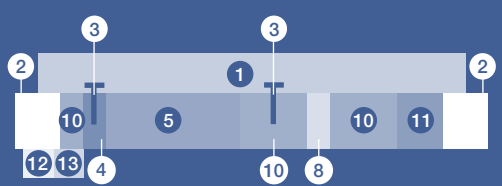


1 Housing
2 Load / Unload Conveyor
3 Central Robot Handling
4 Pre-Cleaning, Saw Damage Removal
5 Alkaline Texturing (ALTEX)
6 Acidic Texturing (ISOTEX)
7 Porous Si-Etch (PorSi)
8 Cleaning
9 Oxide Etch (PSG removal)
10 Rinsing
11 Drying
12 Integrated Process Control
13 Central Machine Control System

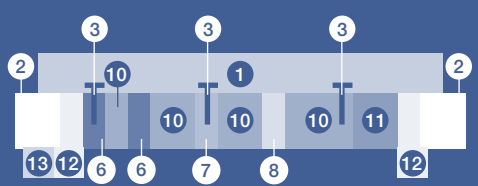
SILEX WB-PSG



SILEX WB-ALTEX



SILEX WB-ISOTEX



Today´s dominating solar cell concept bases on cells made from crystalline silicon. STANGL provides complete automated dry-in/dry-out solutions for wet treatment of Si-wafers in standard and high-efficiency cell lines.

Batch-type working Wet Benches (WB-series) are the “workhorses” for cleaning and etching processes in Si-cell technology. Our machines are matched to the demands of solar cell mass production by

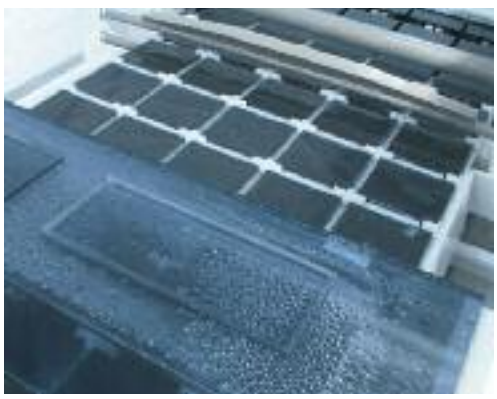
* lowest cost of ownership
* outstanding machine and process reliability
* state-of-the-art design and technology

Main Features

_ Proven, highly integrated design
_ High throughput up to max. 1,500 or 3,000 wph
_ High availability (uptime > 95 %)
_ Low breakage rate (< 0,05 %)
_ High flexibility in
  _ Process sequence
  _ Wafer type
  _ Wafer size
_ Wafer thickness down to 150 µm
_ Internal automatic chemical bath management (replenishment, mixing, bleed and feed)
_ Reproducible process results by complex process parameter control
_ Network communication support
_ Carrier tracking and data logging
_ Compliance with international safety regulations

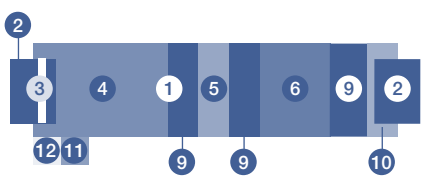
LINEA

Inline Wet Process Equipment for c-Si Solar Cell Production

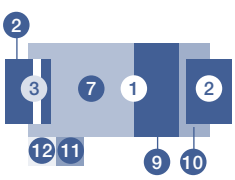


1 Housing
2 Load / Unload Conveyor
3 Wafer Transport System
4 Acidic Saw Damage Etch & Texturing
5 Porous Si-etch (PorSi)
6 Cleaning
7 Oxide Etch (PSG removal)
8 Edge Isolation / Emitter Etch
9 Rinsing
10 Drying
11 Integrated Process Control
12 Central Machine Control System

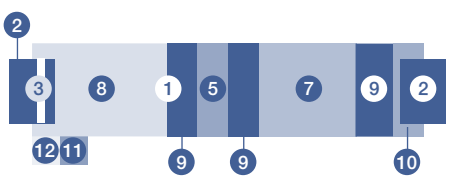
LINEA WL-ISOTEX



LINEA WL-PSG



LINEA WL-PSG-EE



While batch-type working Wet Benches (SILEX-series) are the first choice for cleaning and alkaline texturing of monocrystalline wafers, the manufacturing lines of multicrystalline solar cells preferably apply acidic texturing processes on inline-working machines. PSG Removal processes are running successfully in batch and inline-type equipment, following more or less the philosophy of the whole manufacturing process.

Additionally inline equipment permits single-side etching, applicable for edge isolation or side-selective surface treatment LINEA is a horizontally working inline wet process platform for cleaning and etching of crystalline solar wafers. STANGL's LINEA inline etching system can be configured up to max. 1700 or 3400 wafers per hour (156 mm) which equals a production capacity of 30 and 60 MW. LINEA completes the portfolio of STANGL's integrated wet process solutions for solar cell manufacturing lines.

The LINEA design is based on a newly developed sophisticated transport system and a special chemical flow system to process the wafers horizontally with a very low breakage rate and a high etching uniformity. STANGL's new system LINEA follows the trend towards handling solar wafers down to 150 µm.

Main Features

_ Strongly modular, highly integrated design
_ High availability (uptime > 95 %)
_ Low breakage rate (< 0,1 %)
_ Wafer thickness (down to 150 µm)
_ Newly developed, sophisticated low-contact wafer transport system
_ No mechanical contact on top side
_ Up to 6 lanes 156 mm/125 mm wafer
_ Homogeneous reproducible etching process by high volume chemical up- and downstream distribution system
_ High chemical exchange rate
_ Automatic chemical bath management

SINGULAR

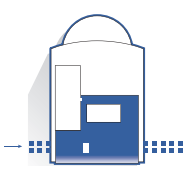
Modular Inline AR Coating System for c-Si Solar Cell Production

_ Capacity up to 1500 wafers/h depending on technical equipment

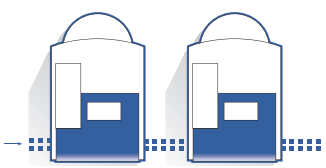
_ Up to 3000 wafers/h as net output capacity

_ Up to 4500 wafers/h as net output capacity

SINGULAR - One Module



SINGULAR - Two Modules



SINGULAR - Three Modules

Solar cell production is making the transition from the pioneering stage towards mass production. Innovative and flexible cell concepts demand a mass production concept which is equally innovative and flexible, as the leap there from the laboratory is the most expensive step in the development process.

SINGULUS has developed the new SINGULAR machine, a PECVD coating system which meets the demands for both current and future PV cell production.

The SINGULAR is a fully automated inline system consisting of independent modules. The essential benefit of the inline technology is the transport and process of small substrate production lots, which guarantees stable processes, continuous output, flexibility and a small footprint.

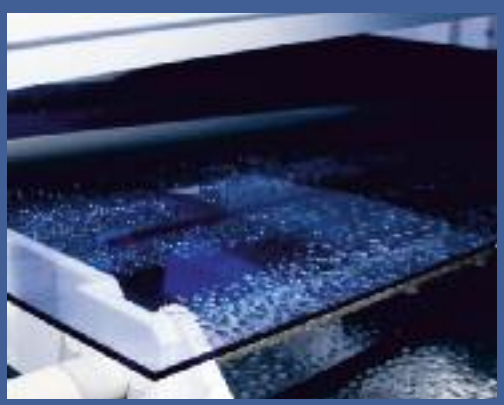
Main Features

For cells 125 x 125 mm and 156 x 156 mm

_ Output 1500 wafers/h, 3000 wafers/h or 4500 wafers/h
_ High uptime due to inline chamber cleaning
_ Efficient raw material consumption
_ Optimized for lowest cost of ownership
_ Integrated automatic loading/unloading system
_ Modular, highly integrated design
_ Short installation and ramp-up time
_ Small footprint

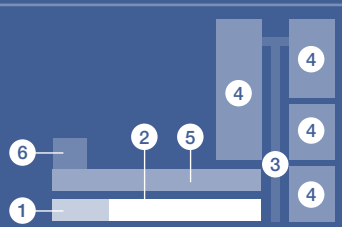
TENUIS

Wet Process Equipment for Thin-Film Solar Cells on Glass



1 Input Transport Unit
2 Brush Off Machine
3 Linear Transport System
4 Process Module
5 Final Rinse
6 Output Transport Unit

TENUIS



With its TENUIS coating machines STANGL has reached an internationally leading position in the CIS / CIGS thin-film technology.

Low manufacturing costs of the CIS modules can only be achieved in mass production. STANGL designs and produces high-tech systems that are used for fully-automated application of the single-sided wet chemical CdS coating.

The fully-automated "dry-in/dry-out" STANGL thin film coating systems, used for single-sided wet chemical CdS coating, offer the customer a safe and reliable production capacity of up to 40/85 MW per line.

Main Features

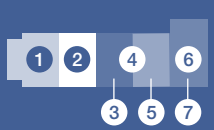
_ Low cost of ownership
_ High throughput (cycle time 60 s)
_ Low process temperatures
_ High availability (uptime > 98 %)
_ Lowest possible chemical consumption
_ Single-side coating
_ Easy upgrade for higher throughput
_ Reproducible process results
_ Automatic dosage and mixing systems
_ Lowest possible DI water consumption
_ Uniform spot-free glass plate drying (dry-in/dry-out)
_ Waste and exhaust management system
_ Networked communication supported

VITRUM

Inline Wet Process Equipment for Thin-Film Solar Cells on Glass

1 Input Transport Unit
2 Process Modules
3 Coarse Rinse
4 Fine Rinse
5 Ultra Fine Rinse
6 Drying Unit
7 Output Powered Roll Gears

VITRUM 1400



VITRUM 2600

The VITRUM wet processing machine is available in different versions, e. g. cleaning, etching, brush off, CdCl2 or KCN. Thin-film solar cells provide the chance to reduce manufacturing costs. This is based on the high costs of crystalline raw material and the better value chain for thin-film solar cells.

Besides the low cost of ownership, the main advantages of VITRUM are the exceptionally high throughput with a cycle time of only 30/60 seconds depending on glass size and process and the modular, highly integrated design. Furthermore, VITRUM offers inline systems for spraying or dipping and the standard and customer specific substrate sizes up to 2600 mm. Moreover, high availability with an uptime of more than 98 % and the integration of automatic dosage and mixing systems are important features of STANGL's new wet processing cleaning machine.

Main Features
_ Low cost of ownership
_ High throughput
_ Inline systems
_ Modular design
_ High availability (uptime > 98 %)
_ Standard and customer specific substrate sizes up to 2600 mm
_ Reproducible process results
_ Automatic dosage and mixing systems
_ Uniform spot-free glass plate drying (dry-in/dry-out)
_ Waste water & exhaust treatment
_ Networked communication supported

IMPEDIO

Roll-to-Roll Wet Process Equipment for Thin-Film Solar Cells on Flexible Materials

1 Input Web
2 Process Module
3 Rinsing and Drying Module
4 Output Web

IMPEDIO

Thin-film solar cells on flexible materials are on the advance due to their potential applications regarding low weight, high flexibility and low cost of manufacturing compared to silicon based solar cells.

STANGL offers roll-to-roll production systems of the type IMPEDIO for the wet-chemical coating of solar cells based on CIS/CIGS technology.

Roll to Roll – IMPEDIO product portfolio for thin-film technology on foils (metal/plastic):

_ Roll-to-Roll Chemical Bath Deposition (CBD) of CdS/alternative buffer layers for CIS, CIGS, CIGSSe technologies
_ Roll-to-Roll Inline-Cleaning (DI-Water, Tensides)
_ Roll to Roll Inline-Etching (KCN, HCl, H3PO4)

STANGL also supplies the following facillity management systems e.g. chemical supply systems, chemical mixing systems and waste water treatment.

Main Features
_ Low cost of ownership
_ Low process temperatures
_ High availability (uptime > 98 %)
_ Lowest possible chemical consumption
_ Single-side coating of CdS or alt. buffer layers
_ Both side etching with spray or dipping processes
_ Both side cleaning with spray process
_ Reproducible process results
_ Automatic dosage and mixing systems
_ Lowest possible DI water consumption
_ Uniform spot-free foil drying (dry-in/dry-out)
_ Waste and exhaust management system
_ Networked communication supported

SINGULUS & STANGL

A Strong Player in Silicon & Thin-Film Solar Technology.

SINGULUS and STANGL will systematically expand the solar activities. Both companies complement each other ideally in being able to offer a broad product range of machines and equipment for the photovoltaics industry in the coming years.

In addition to the expansion of the production range at STANGL with several wet-chemical processes for silicon and thin-film solar cells already established in the market, SINGULUS has the required expertise for vacuum coating and automation technologies to develop complex machines for new cell concepts and to produce these cost-efficiently.

SINGULUS developed a machine for the coating of silicon solar cells. This machine was introduced to the market in 2009 and is an important building block in the production process of solar cells. In terms of the value-added chain it ties directly to the processing steps of the machines offered by STANGL.

STANGL designs and produces high-tech systems that are used for fully-automated application of the single-sided wet chemical coating. STANGL is world market leader with the TENUIS Wet Process Equipment for thin-film solar cells on glass. STANGL and the Helmholtz Zentrum Berlin für Materialien und Energie (HZB) presented a new process for the production of thin-film solar cells.

The new spray ion layer gas reaction process (ILGAR) will be used for the application of indium sulfide buffer layers, which are capable of replacing poisonous cadmium sulfide in specific thin-film solar cells. The spray technology is reproducible, fast and cost-efficient and suitable for scaling up into an inline process on large areas. STANGL will exclusively market the new ILGAR process for thin-film solar cells on glass and foil.

It is intended to cover additional process steps in the manufacturing of solar cells in the coming years with the newly-developed machines and thus to broaden the value-added chain of our company in the solar segment.

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