LINEA

Inline Wet Process Equipment for Cleaning, Texturing and PSG Removal

SINGULUS
Smart Solutions to Drive the Future.

SINGULUS TECHNOLOGIES focuses on Photovoltaics: Smart Solutions for Crystalline Silicon & Thin Film Solar Technology

SINGULUS TECHNOLOGIES is the world leader in manufacturing mass production equipment for Optical Discs CD/DVD/Blu-ray. In the Solar segment, SINGULUS and STANGL are cooperating with leading cell manufacturers in the development of new technologies and new plant concepts for improved cell concepts with higher efficiency and production technologies with decreasing production costs. The company's target is to position itself at the forefront for the introduction of new technologies with respect to silicon as well as thin film solar technology. During times of cost pressures in the photovoltaics market, the interest regarding new plant concepts increases. In the coming years, SINGULUS will offer a broad product range of new machines for the photovoltaics industry, which will offer manufacturers of both silicon and thin-film cells new production technologies and particular cost advantages.

SINGULUS and SINGULUS STANGL SOLAR 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.

Crystalline Silicon Solar Technology
In the area of crystalline silicon solar technology, SINGULUS TECHNOLOGIES delivered the first SINGULAR inline coating machine for anti-reflective coating of silicon solar cells as well as STANGL's newly developed inline cleaning system LINEA with the corresponding fully-automated wafer handling system in November 2009. Since that time, SINGULUS realized the first installation of a so-called front-end system. A European solar cell manufacturer accepted the first setup in early July 2010 including two LINEA and one SINGULAR system.

The company's goal with respect to silicon solar technology is to assume a leading position in the market by launching new production technologies. In the future SINGULUS will not only supply individual machines and equipment for the silicon solar technology but will also actively market so-called front end systems as well as complete production systems for the cell production with process know-how in the solar market. SINGULUS and STANGL already possess the fundamental expertise for wet-chemical and AR-coating processes. This enhancement of the business model from single machines towards systems was also successful in the Optical Disc market some years ago.

LINEA – Inline Wet Process Equipment for Cleaning, Texturing and PSG removal

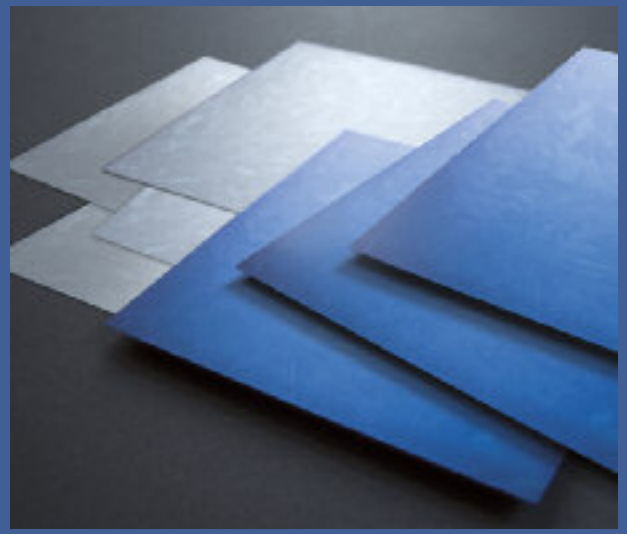
Today´s dominating solar cell concept is based on cells made from crystalline silicon. STANGL provides complete automated dry-in/dry-out solutions for wet treatment of Si-wafers in standard and high-efficiency cell lines.

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 texture 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.

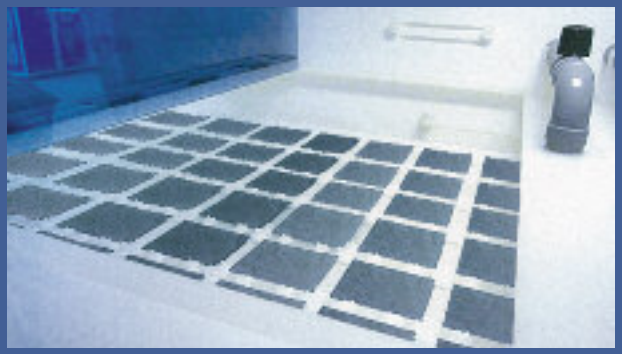
Additionally, inline equipment permits single-side etching, applicable for edge isolation or sideselective surface treatment. LINEA is a horizontally working inline wet process platform for cleaning and etching of crystalline solar wafers. LINEA inline etching system can be configured up to max. 1,700 or 3,400 wafers per hour (156 mm) which equals a production capacity of 50 and 100 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.

The highly integrated design, high throughput, high availability and low breakage rate make LINEA attractive for solar cell manufacturers worldwide.



LINEA – Inline Wet Process Equipment for c-Si Solar Cell Production



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

STANGL Wet Process Machines in c-Si Solar Cell Production Lines

Si-Cell Production Step-by-Step: STANGL – LINEA | STANGL | SINGULUS – SINGULAR

Maintenance & Support: Boat Cleaning | Wafer Rework | Chemical Supply Systems

Main Components

1 Housing
_ Stable modular main frame, completely covered by PP-panels
_ Integrated systems for bath management, electrical cabinets and process control units

2 Load / Unload Conveyor
_ Automated feed-in of a wafer alignment by optional multiplex transfer unit
_ Automated take-out of wafers by optional single or multiplex pick-and-place unit
_ Safety interlock of automation interaction

3 Wafer Transport System
_ Motor-driven plastic conveyor chain in interaction with o-ring based belt transfer sections guarantees a reliable and gentle wafer motion and a minimum of mechanical wafer stress
_ 6 transport lanes, designed for 156 mm or 125 mm wafer
_ Effective media carry-over protection system between process sections
_ Transport speed adjustable

4 Acidic Etch (Saw Damage Removal, Texturing, Polishing)
_ Removal of crystalline surface defects by using HF-HNO_3 composition
_ Fluidised bed process by adjustable up- and downflow streams of acid mixture
_ Single side etching optional (polishing)
_ High-flow bath recirculation in association with the effective chilling system
_ Excellent temperature and etch uniformity control

5 Porous Si-Etch (PorSi)
_ Short etching process of porous Si layer in cold alkaline solution

6 Cleaning
_ Acidic cleaning using HF and HCl for effective removal of metal contaminations and native oxides

7 Oxide Etch (PSG removal)
_ Removal of P-SiO_2-layer from wafers, formed during previous diffusion process
_ Ambient cleaning operation for subsequent antireflective coating
_ Self-limiting HF etch step

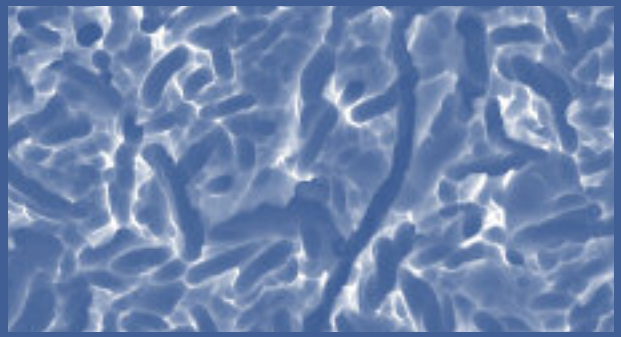
8 Edge Isolation / Emitter Etch (EE)
_ Single side etch of wafer rear side without front side treatment
_ Excellent edge isolation and parasitic emitter etch, using chilled HF/HNO_3 compositions

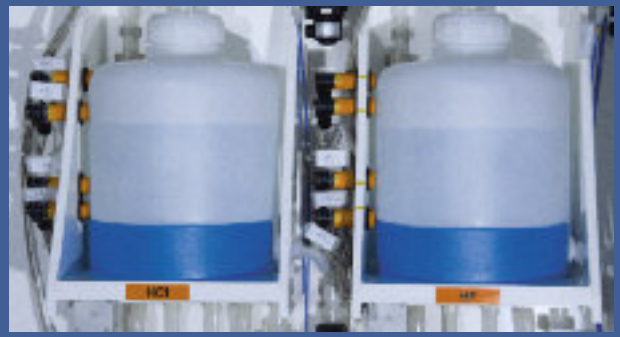
9 Rinsing
_ Intelligent combination of highly effective flow and spray rinse
_ Cascade system with partial water re-use

10 Drying
_ Air jet system, using clean ambient air ensures smooth, perfect uniform and spot-free drying of wafers

11 Integrated Process Control
_ Individual chemical bath management for filling and spiking of chemicals and DI-water
_ Temperature control of all heated and cooled process steps
_ Control of recirculation and injection flow rates
_ Transport speed control
_ Optional online/offline analysis of chemical compositions by titration, conductivity measurement and/or IR spectroscopy
_ DI-water resistivity measurement
_ Process data storage and logging
_ Single wafer tracking

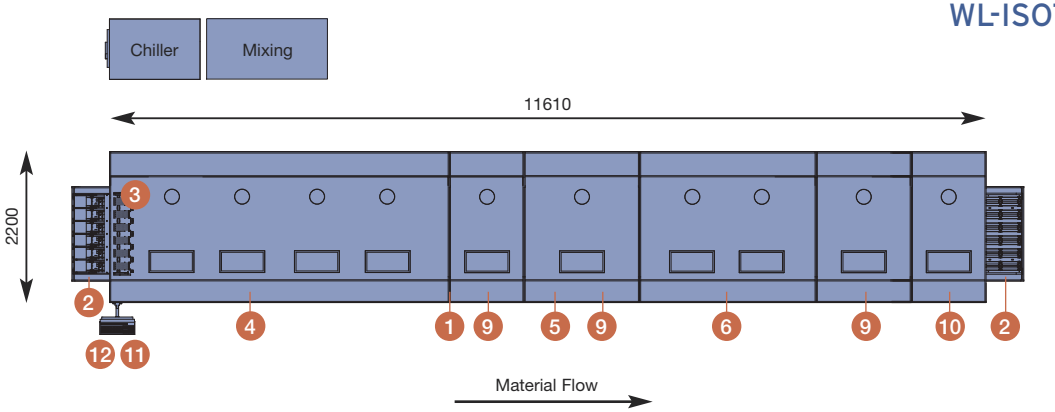
12 Central Machine Control System
_ Siemens SIMATIC S7 PLC system
_ PC-based graphical user interface (WINCC)
_ Bus systems for internal communication of sub-assembly systems
_ OPC interfaces for external data exchange
_ Safety gas transmitter system (NOX, HF)





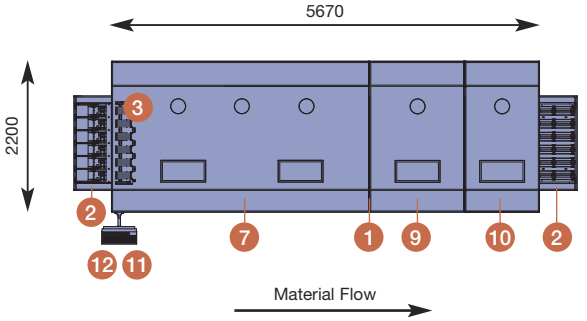
Main Features	LINEA WL-ISOTEX1500	LINEA WL-ISOTEX3000
Dimension L/W/H mm:		
Wet line	8640/2200/2300	11610/2200/2300
Chiller station	1000/600/1500	1200/800/1500
Mixing tank	800/800/2300	1600/800/2300
Option sump pump tank	2000/500/600 per unit	2000/500/600 per unit
Capacity:		
156 mm	6 lanes / 1700 wph	6 lanes / 3400 wph
125 mm	6 lanes / 2000 wph	6 lanes / 4000 wph
Wafer Material:	Si MC, 125x125 mm, 156x156 mm, >150 µm	
Utilities:	N_2, CDA, DI-water, PCW, HF, HNO_3, KOH, HCl, (additive) waste drains electrical power 400 VAC/3/PE	
Exhaust:	5000 m³/h	6500 m³/h
Typical Ablation/Side:	4-6 µm	4-6 µm

WL-ISOTEX



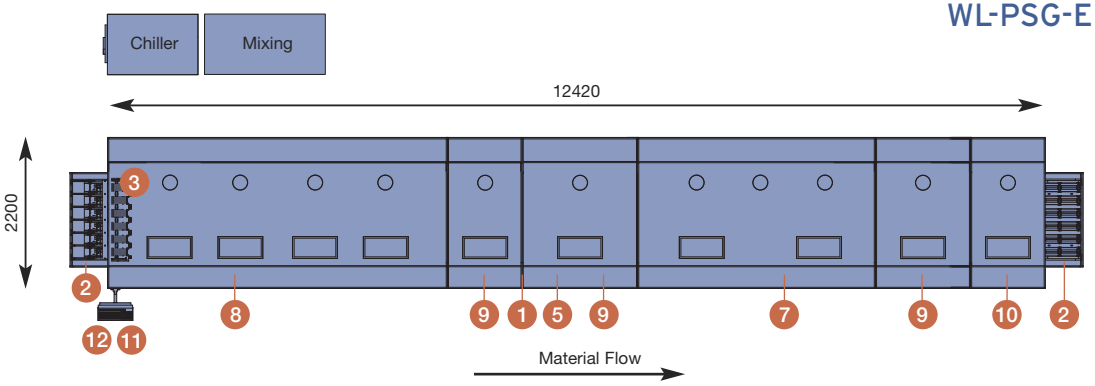
Main Features	LINEA WL-PSG1500	LINEA WL-PSG3000
Dimension L/W/H mm:		
Wet line	4590/2200/2300	5670/2200/2300
Option sump pump tank	2000/500/600 per unit	2000/500/600 per unit
Capacity:		
156 mm	6 lanes/1700 wph	6 lanes/3400 wph
125 mm	6 lanes/2000 wph	6 lanes/4000 wph
Wafer Material:	Si MC, CZ, 125x125 mm, 156x156 mm, >150 µm	
Utilities:	N_2, CDA, DI-water, HF waste drains electrical power 400 VAC/3/PE	
Exhaust:	2500 m³/h	3200 m³/h
Typical Ablation:	50-250 µm	50-250 µm

WL-PSG



Main Features	LINEA WL-PSG-EE1500	LINEA WL-PSG-EE3000
Dimension L/W/H mm:		
Wet line	9180/2200/2300	12420/2200/2300
Chiller station	1000/600/1500	1200/800/1500
Mixing tank	800/800/2300	1600/800/2300
Option sump pump tank	2000/500/600 per unit	2000/500/600 per unit
Capacity:		
156 mm	6 lanes / 1700 wph	6 lanes / 3400 wph
125 mm	6 lanes / 2000 wph	6 lanes / 4000 wph
Wafer Material:	Si MC, CZ, 125x125 mm, 156x156 mm, >150 µm	
Utilities:	N_2, CDA, DI-water, PWC, HF, HNO_3, KOH, waste drains electrical power 400 VAC/3/PE	
Exhaust:	5500 m³/h	7000 m³/h
Typical Ablation:	2-4 µm	2-4 µm

WL-PSG-EE



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