

VITRUM

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

Cleaning - Etching - Coating



STANGL & SINGULUS – Smart Solutions to Drive the Future

VITRUM

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

The Semiconductor industry has enjoyed more than 40 years of success since its sophisticated technology was enthusiastically embraced. Today, the commercial use of the photoelectrical effect for photovoltaic power generation is poised for similar success as it prepares for conversion to fully automated mass production.

STANGL Semiconductor Equipment AG – a German manufacturer of qualified wet process equipment – entered the booming semiconductor industry in the late 1980's. Their expertise is based on 20 years of experience in the planning, design, assembly and implementation of wet process machines for semiconductor and solar cell manufacturing.

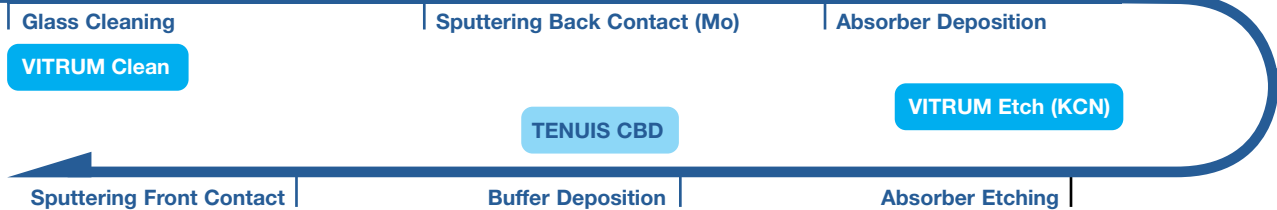
With STANGL continuing to experience strong growth rates, SINGULUS TECHNOLOGIES has made the decision to rapidly expand the solar segment.



VITRUM - Three Available Machine Designs

Process Flow Step-by-Step with ■ STANGL - VITRUM ■ STANGL

CIS/CIGS Process Flow



CdTe Process Flow



a-Si Process Flow



Thin-film solar cells give you 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.

VITRUM: Thin-Film Technology on glass substrates, product portfolio

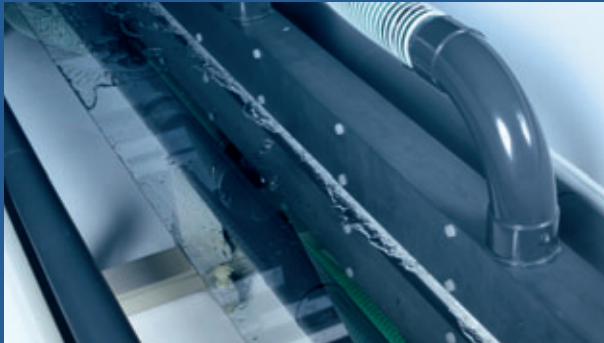
- Inline Cleaning equipment (2600/1400)
 - _ Pre Rinse & Single side brush off (acid/caustic)
 - _ Inline Final Rinse (cascade cleaner)
 - _ Inline Polishing Equipment (glass corrosion)
- Inline Etching equipment (2600/1400)
 - _ Inline TCO (0,5 % HCl) etcher
 - _ Inline KCN etcher
 - _ Inline H₃PO₄/HNO₃ etcher
 - _ Inline CuCl₂ etcher
 - _ Inline CdCl₂-single side coating equipment

Facility Management

STANGL also supplies the following facility management systems:

- _ Chemical Supply Systems
- _ Chemical Mixing Systems
- _ Waste Water Treatment

STANGL Wet Process Tools Ensure Economic and Reliable Production



VITRUM 1400 – R&D

Inline Etching Equipment

- _ Substrate size from 300 to 1400 mm
- _ Technology: spray etching/dip etching/spray under immersion
- _ Fully automatical system (dry in-dry out)
- _ Fully automatical process solution management

VITRUM 1400/2600 – PRODUCTION

Inline Etching Equipment

- _ Substrate size from 1400 to 2600 mm
- _ Combined/parallel transport of smaller substrates possible
- _ Technology: spray etching/dip etching/spray under immersion
- _ Cycle time up to 50 sec.
- _ Fully automatical system (dry in-dry out)
- _ Fully automatical process solution management

Technical Features

- _ Low cost of ownership
- _ High throughput (cycle time 50 s)
- _ 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
- _ Compliant with European/U.S. safety regulations

Main Components

1 Input Transport Unit

Substrate will be transported by the “Input Transport Unit” without touching the absorber/process surface into the Inline process module

Consists of:

- _ Housing in PP
- _ PVC-clear cover to protect the substrate
- _ Separate driven conveyor belt or roll gears with adjustable speed
- _ Rotary table (LEL/SEL) for direction change
- _ Lift station for dispatch level adaption
- _ Accelerating/Deceleration function

2 Process Modules

- _ Inline spray etching/dip etching/spray under immersion
 - HCl-etching @ ambient temperature (TCO etch)
 - KCN-etching @ ambient temperature (selective removal of CuS on CIS absorber)
 - Single side coating with CdCl₂ @ ambient temperature (activation of CdTe absorber)
 - H₃PO₄/HNO₃/DI-etching @ ambient temperature (stabilization of CdTe absorber)
 - CuCl₂ treatment @ 20-40 °C (Cu dope of CdTe absorber)

Consists of:

- _ Housing in PP
- _ Equipped with leakage sensors
- _ Etching modules are equipped with double protection windows in PVC
- _ Circulation of the water/chemicals by a radial pump and filter station
- _ Spray bars from the top and bottom
- _ Roll gears with adjustable speed

- _ Stripping rollers on backside, separator air knives from the top to separate chemicals from rinsing steps
- _ Separate exhaust system

3 Coarse Rinse

Coarse cleaning of the substrates

Consists of:

- _ Housing in PP
- _ Roll gears with adjustable speed
- _ Circulation of the water by a radial pump and filter station
- _ Minimized fresh water consumption by using cascade system and conductometry measurements
- _ Roller conveyor with spray bars from the top and bottom
- _ Stripping rollers on backside, separator air knives from the top to separate the water qualities
- _ Separate exhaust system

4 Fine Rinse

Fine cleaning of the substrates

Consists of:

- _ Housing in PP
- _ Roll gears with adjustable speed
- _ Circulation of the water by a radial pump and filter station
- _ Minimized fresh water consumption by using cascade system and conductometry measurements
- _ Roller conveyor with spray bars from the top and bottom
- _ Stripping rollers on backside, separator air knives from the top to separate the water qualities
- _ Separate exhaust system

5 Ultra Fine Rinse

Ultra fine cleaning of substrate

Consists of:

- _ Housing in PP
- _ Roll gears with adjustable speed
- _ Circulation of the water by a radial pump and filter station
- _ Minimized fresh water consumption by using cascade system and conductometry measurements
- _ Roller conveyor with spray bars from the top and bottom
- _ Stripping rollers on backside, separator air knives from the top to separate the water qualities
- _ Fresh water spray bars at the outgoing of the module
- _ Separate exhaust system

6 Drying Unit

Drying of the substrates (physical remove of water)

Consists of:

- _ Housing in PP
- _ Roll gears with adjustable speed
- _ Air knives from top and bottom
- _ Integrated radial ventilator for air supply

7 Output Powered Roll Gears

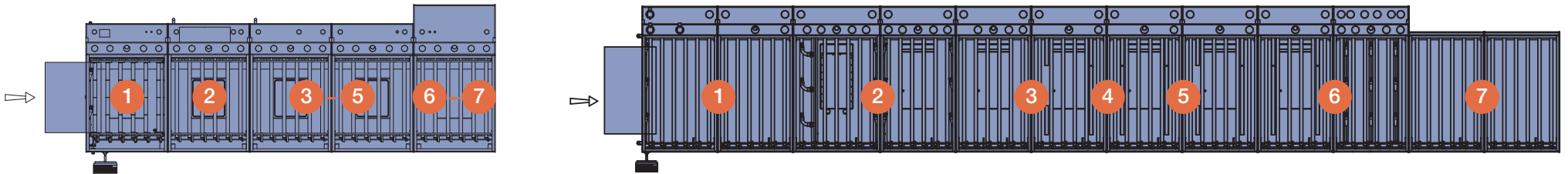
Substrate will be transported/accelerated/decelerated at the output Integration of measurement systems

Consists of:

- _ Housing in PP
- _ PVC-clear cover to protect the substrate
- _ Separate driven conveyor belt or roll gears with adjustable speed
- _ Rotary table (LEL/SEL) for direction change
- _ Lift station for dispatch level adaption

VITRUM 1400

VITRUM 2600

**Main Features****VITRUM 1400 – PRODUCTION**

| | |
|--|---|
| Dimension L/W/H (mm) | 8050/2940/2200 Short Feed Pipe |
| Equipment | 8050/2940/2200 Short Feed Pipe |
| Dimension L/W/H (mm) | |
| Radial Ventilator | 2300/2100/1600 |
| Dimension L/W/H (mm) | |
| Chemical Supply System | 1200/1000/2800 |
| Dispatch/Hand Over (mm) | 900 +/- 10 mm |
| Capacity | 60 Substrates/h |
| Substrate Material | Glass Substrate |
| Substrate Size (mm) | 1400 x 1200, typ. Thickness 3-5 1400 x 1100, typ. Thickness 3-5 1200 x 600, typ. Thickness 3-5 |
| Transport Orientation | 1 pc. 1400 x 1200, Transport Direction LEL 1 pc. 1400 x 1100, Transport Direction LEL 1 pc. 1200 x 600, Transport Direction LEL |
| Transport | Inline |
| Exhaust, cont. | Appr. 2000 m ³ /h |
| Exhaust, uncont. | Appr. 3500 m ³ /h |
| Utilities/Media Supply & Disposal | CDA Class 3, N ₂ (CDA class 1), Cooling Water Supply, Cooling Water Return, DI-Water, Waste Water, Conc. Waste |
| Process Chemicals, Supply | HCl, H ₃ PO ₄ /HNO ₃ , CuCl ₂ , KCN, CdCl ₂ |

Main Features**VITRUM 2600 – PRODUCTION**

| | |
|--|--|
| Dimension L/W/H (mm) | 19600/3400/2750 Short Feed Pipe |
| Equipment | 19600/3400/2750 Short Feed Pipe |
| Dimension L/W/H (mm) | |
| Radial Ventilator | 2300/2100/1600 |
| Dimension L/W/H (mm) | |
| Chemical Supply System | 1200/1000/2800 |
| Dispatch/Hand Over (mm) | 1000 +/- 10 mm |
| Capacity | 60 Substrates/h |
| Substrate Material | Glass Substrate |
| Substrate Size (mm) | 1400 x 1200, typ. Thickness 3-5 1400 x 1100, typ. Thickness 3-5 2600 x 2200, typ. Thickness 3-5 |
| Transport Orientation | 2 pc. 1400 x 1200, Transport Direction SEL 2 pc. 1400 x 1100, Transport Direction SEL 1 pc. 2600 x 2200, Transport Direction SEL |
| Transport | Inline/2 Substrates in parallel possible |
| Exhaust, cont. | Appr. 4700 m ³ /h |
| Exhaust, uncont. | Appr. 9800 m ³ /h |
| Utilities/Media Supply & Disposal | CDA Class 3, N ₂ (CDA class 1), Cooling Water Supply, Cooling Water Return, DI-Water, Waste Water, Conc. Waste |
| Process Chemicals, Supply | HCl, H ₃ PO ₄ /HNO ₃ , CuCl ₂ , KCN, CdCl ₂ |



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