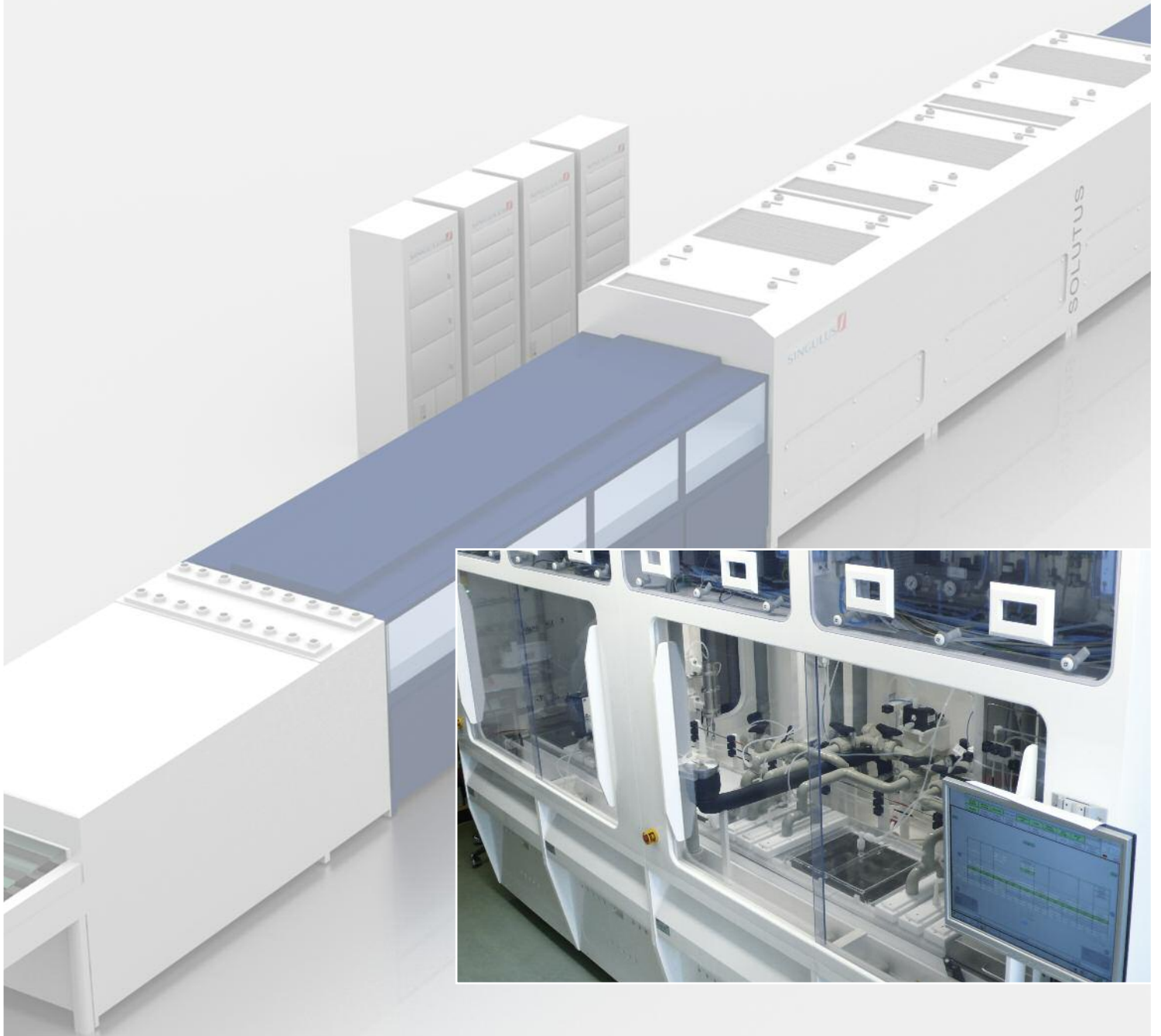
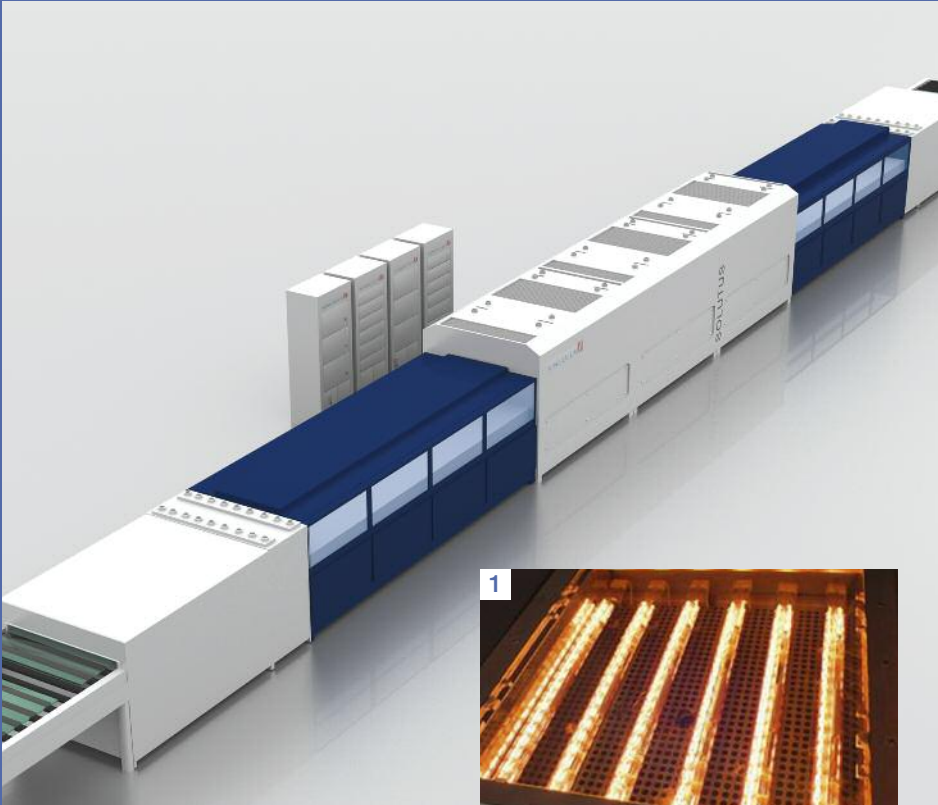


SOLUTUS

Inline System for Spray Ion Layer
Gas Reaction (ILGAR®)

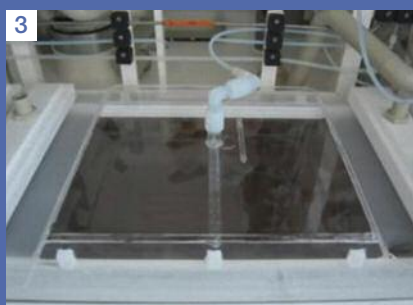
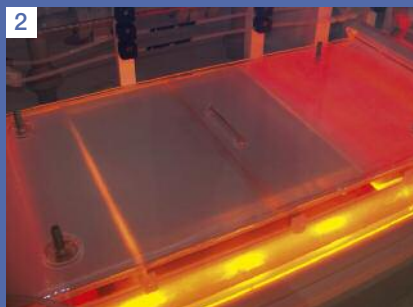


SOLUTUS - Inline System for Spray Ion Layer Gas Reaction (ILGAR®)



Process Chambers of the ILGAR® Lab System

1. Pre-heating station
2. InCl_3 -deposition chamber
3. H_2S chamber



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 striving for 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, with new production technologies and particular cost advantages for manufacturers of both silicon and thin film cells. 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.

Thin film solar panels offer specific advantages compared to silicon solar technology. Amongst these is the retention of efficiency during periods of weak sun intensity and an easy integration into architectural design elements. SINGULUS is the market leader for the wet-chemical cleaning for CIS and CdTe processes. New production concepts as the spray ion layer gas reaction (ILGAR®) process expand the value-added chain in the area of thin film solar technology. SINGULUS will progress on the way to become a system supplier in this segment.

Spray Ion Layer Gas Reaction (ILGAR[®]) – The Alternative Buffer for Thin-Film Solar Cells on Glass or Foils (CIS or CdTe)

The standard buffer layer in a chalcopyrite thin film solar cell is made by chemical bath deposition (CBD). This is a reliable and commercially accepted method. However it also has a number of disadvantages such as: long process times, large amounts of liquid waste, critical process parameters, an inherent batch type nature and difficulties with very large substrates. As the size of the substrates used in thin film production increases and the tact time decreases there is a request for new methods with the buffer layer deposition as one example.

In a collaboration between Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), formerly the Hahn-Meitner-Institut (HMI), and SINGULUS, an alternative buffer layer deposition technique has been developed for thin film solar cell fabrication. The so-called Ion-Layer-Gas-Reaction Process (ILGAR[®]) offers a new, cost efficient, chemical method to manufacture a thin homogeneous In_2S_3 layer (20 nm), as an alternative to the common CdS-buffers.

The Spray-ILGAR[®] deposited indium sulfide buffer layers are capable to replace the cadmium sulfide buffers used in chalcopyrite cells in order to avoid the toxic cadmium. First 30x30 mini-modules on a Pilotline $\text{Cu}(\text{In,Ga})(\text{S,Se})_2$ absorbers achieved an efficiency of 13.0 % after light soaking. The nature of the spray technique ensures that the ILGAR[®] process is reproducible, fast, cheap and suitable for scaling up into an in-line process on large area substrates.

Main Features

- _ AACVD atmospheric process (aerosol assisted chemical vapor deposition)
- _ No vacuum required
- _ Quasi-dry process
- _ In_2S_3 -deposition technique
- _ Cadmium free
- _ High efficiency cells produced with potential for further improvement (certified efficiency of 14.7 % measured at ISE Freiburg)
- _ Machine cycle 60 s
- _ Continuous substrate flow under the aerosol area
- _ Design for variable size of production substrates: substrate width up to 1,200 mm (larger substrate size can be processed on request)
- _ Inline, fast production speeds
- _ Flexible method: bi-layers and mixed compositions possible

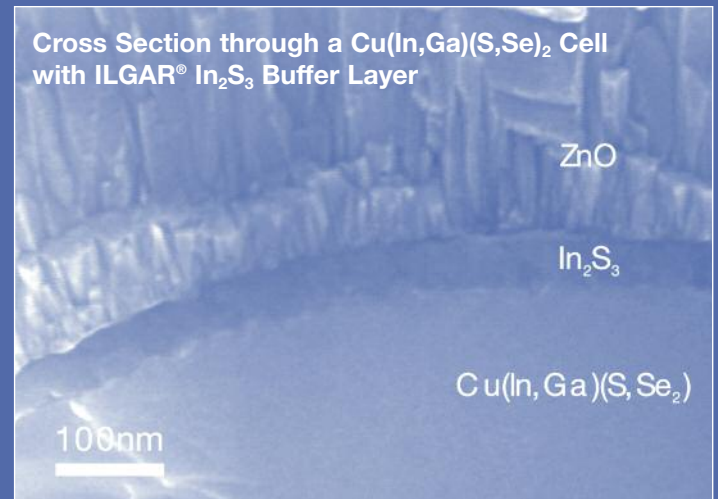
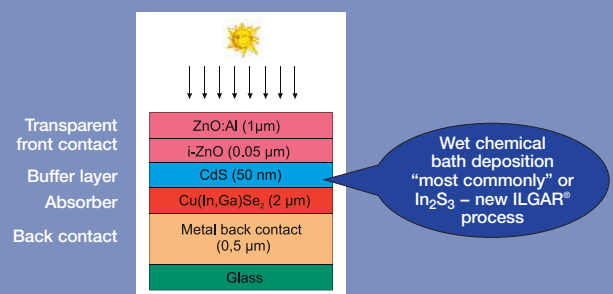


Image with kind permission of HZB

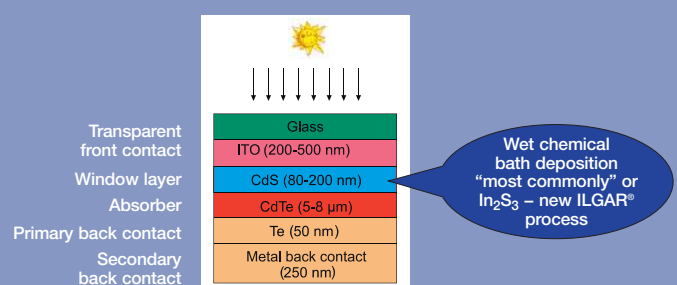
Buffer Layer for CIS-Cells

- _ CIS/CIGS cells are normally arranged in a "Substrate configuration"
- _ the layer stack is deposited on a glass substrate
- _ the cell structure starts with sputtering of the metal back contact (Mo)



Buffer Layer for CdTe-Cells

- _ CdTe cells are normally arranged in a "Superstrate configuration"
- _ the layer stack is deposited on a glass substrate
- _ the cell structure starts with sputtering of the front contact (TCO)





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