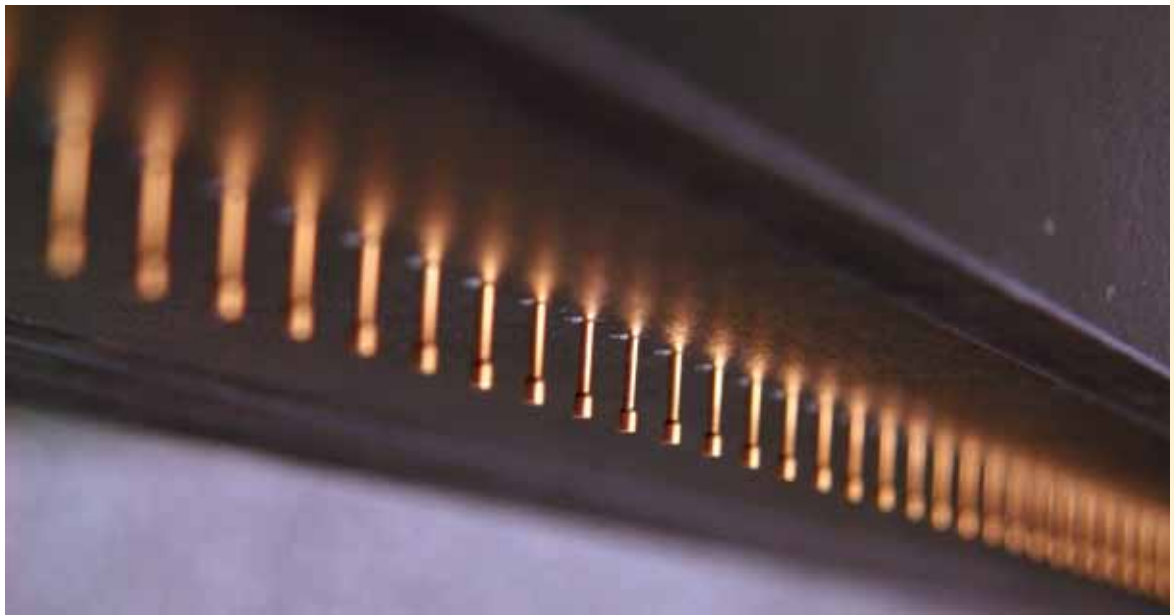


Solar Measure



Measurement Solutions for Thin Film Solar Modules



All-around Solutions from Dr. Schenk: Enhance your Inspection System by Adding Measurement Options

Dr. Schenk offers all-in-one quality assurance and process control systems for the production of solar panels. The surface inspection system, SolarInspect, can now be combined with beneficial measurement tasks in just one solution for higher yield. The products of the SolarMeasure family perform electrical and physical measurement and are available as an add-on option to the optical analysis or as stand-alone systems.

- ▶ **Quality Control**
Establish quality standards and sort out panels that do not meet them
- ▶ **Process Control**
Improve YIELD by quickly identifying the source of a defect and fixing the problem right away
- ▶ **Microscope Station for Scribe Analysis**
- ▶ **Electrical Insulation Tester**
- ▶ **Layer Thickness Monitoring**
- ▶ **Resistivity Measurement**
- ▶ **Haze Monitoring**
- ▶ **Dimension Measurement**

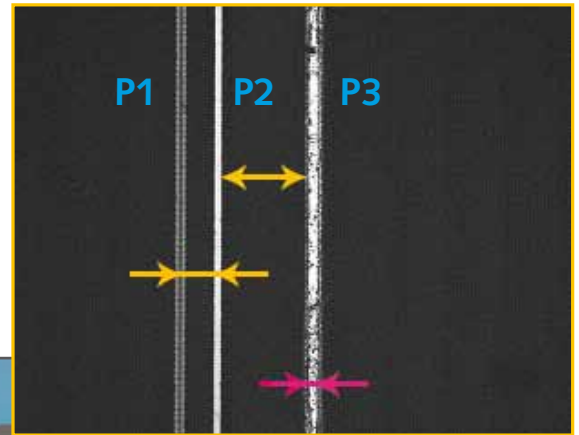


Microscope Station

Based on a high resolution matrix camera the Microscope Station has been developed as measurement solution with focus on width and distance between scribe lines. Both are crucial for an optimized cell performance.

The Microscope Station measures in-situ:

- Width of scribe line P_x
- Distance of scribe line P_x to P_y



— Scribe Intervals
— Scribe Width

The Dr. Schenk Microscope Station enables fast reaction on deviations of the scribing process and, thus, helps to raise yield and optimize the production process. This measurement solution is the perfect enhancement to a surface inspection system.

Key Advantages

- Highest pixel resolution of the matrix camera (< 3 µm)
- Autofocus function to compensate panel warpage
- Spot check for each individual scribe head
- Optimized illumination unit for reliable images
- No interruption of the panel movement
- Ideal combination with SolarInspect
- Also available as stand-alone system



Measurement Solutions for Solar Panels

Resistivity Measurement

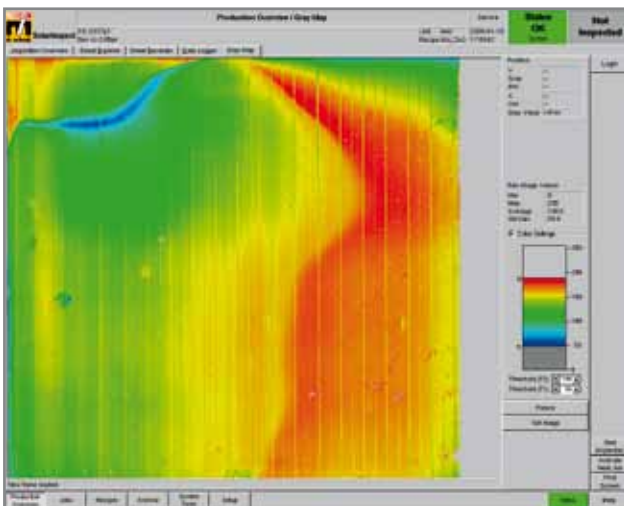
This add-on option to thin film module inspection measures the sheet resistance of the solar panel's substrate coating. For an optimized panel efficiency, the conductivity of the coating layer should be at a maximum even at a low layer thickness.

As an helpful add-on to solar module inspection, Dr. Schenk offers a high sensitive sensor, that performs a non-contact measurement of the resistivity. This in-line measurement is making use of the Eddy current principle. In its down-web movement along the line, the coated solar glass passes through the sensor's magnetic field of the coil of a high-frequency circuit.

The sensor is connected with the SolarInspect system and its analysis software, the visualization terminal will report a visual alarm, as soon as the preset recipe parameters are exceeded.



An optional sensor measures the resistivity of the TCO layer on the glass substrate



False Color Image of Layer Thickness

Layer Thickness Monitoring

With this innovative option PV manufacturers can monitor local thickness variations after layer deposition steps covering the entire panel area. It supports the control of the coating process.

- Using same hardware set-up as defect analysis
- Layer thickness monitoring and inspection run parallel
- Enhanced technology to process the optical signals
- Real time 2D visualization map (see image left)

As the thickness monitoring requires high-resolution, low-noise cameras and high performance LED illumination units operating at selective wavelengths this measurement option is best planned to be integrated into the inspection system at an early stage. The costs for a second hardware set can, thus, be saved and the solar panel inspection system becomes a true all-around solution.

For layer thickness measurement, as for e.g. in-line spot test or in off-line laboratory situations, Dr. Schenk alternatively offers a technology using a white light spectrometer.

Your Reliable Partner

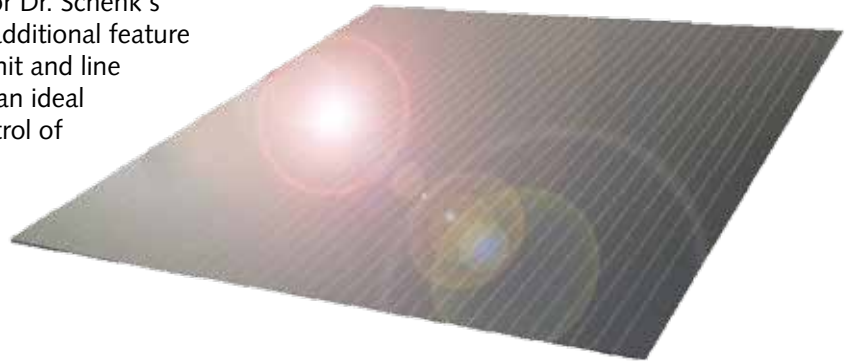


Solar Measure

Dimension Measurement

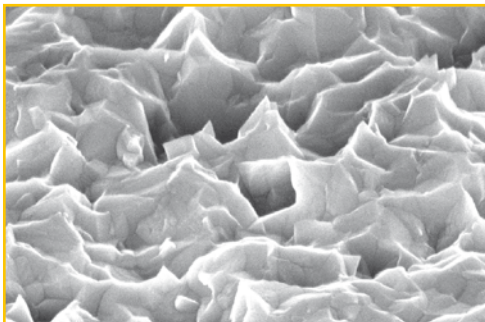
Focus of this measurement option are length, width and squareness of the glass panels which are primarily analyzed at the beginning of the production line.

The Dimension Measurement option for Dr. Schenk's solar inspection systems comprises an additional feature using the optical set-up (illumination unit and line camera) of SolarInspect. It is therefore an ideal upgrade for higher yield and extra control of the incoming glass panel quality.



Haze Monitoring

In order to increase the efficiency of thin film solar panels, specific layers of the panels receive a surface structure. Especially important to the TCO layer of a-Si PV modules, this layer roughness or haze will increase the light trapping effect. Manufacturers are aiming to keep this effect constant and at an optimized level throughout the production run in order to guarantee highest panel efficiency.



The ideal haze intensity of solar panels' conductive layers will optimize the light trapping effect and thus, the cell efficiency

Dr. Schenk's Haze or Light Trapping Monitoring option has been developed in order to check the layer structure of incoming TCO coated glass delivered by the glass supplier as well as solar glass after the coating step at the fab. As soon as process deviations occur, the system reports a variation in the panels' haze intensity and operators can react fast to adjust production parameters.

Using the same optical set-up as for Dr. Schenk's SolarInspect system, the Haze Monitoring option is a perfect enhancement for quality and process control.

- Using same hardware set-up as defect analysis
- Haze monitoring and inspection run parallel
- Enhanced technology to process the optical signals
- Real time 2D visualization map

For in-line spot tests or for use in off-line situations Dr. Schenk offers an alternative sensor for absolute measurement of haze intensity at a given panel position.



Measurement Solutions for Solar Panels

Electrical Insulation Tester

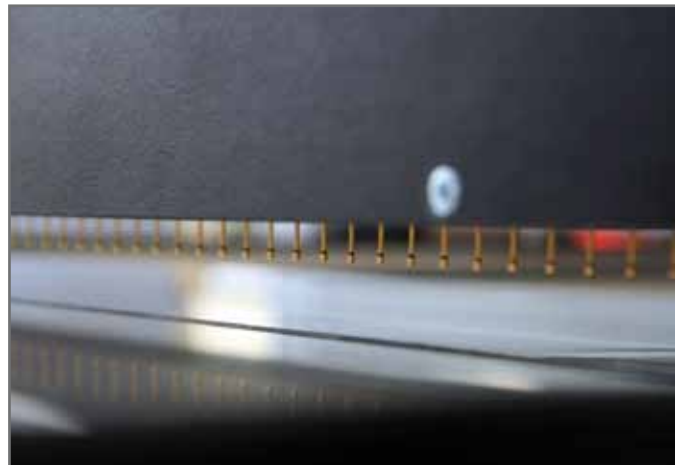
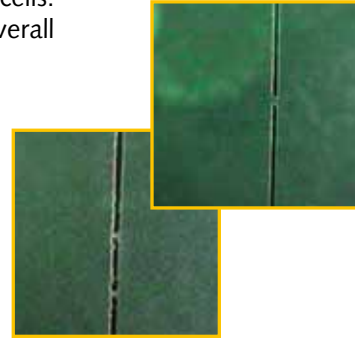
This enhanced measurement solution performs an electrical insulation test between the solar cells after scribing. As ideal endorsement to surface inspection it is available as add-on to Dr. Schenk inspection systems or as stand-alone product.

The system detects shorts and minimum resistance between neighboring cells. Both situations can result in a loss of cell performance and by this in an overall reduction of the performance of the solar module.

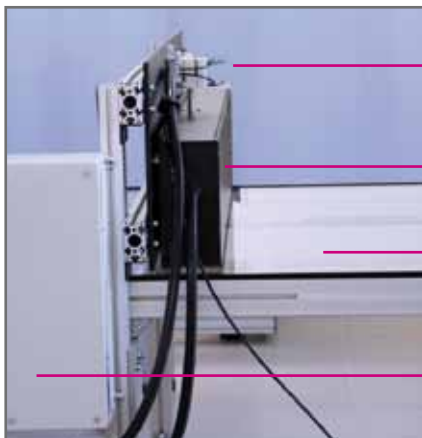
Key Advantages

- Modular system design
- Fast measurement cycle: < 3s
- Insulation threshold adjustable
- Spring mounting of probes
- High durable probes
- Quick release mounting contact bar
- Low costs of wearing parts
- Adaptable to all substrate sizes and any number of cells
- De-energized position of probes in retracted position for operational safety

Discontinuity of scribes will cause short circuits



Components:



Pneumatic system to lift and lower the contact bar

Measurement interface with row of metal contact probes

Production line with solar panel

Controller box including a single board computer

For fully automated production lines the system does not even require a visualization/operation software as it communicates directly with the line control unit and sends signals to restart the line flow.

Your Reliable Partner



Dr. Schenk's modern production site

Dr. Schenk GmbH, established in 1985, is an innovative high-tech company based in Munich, Germany. For the third decade now, the range of products and services offered by Dr. Schenk comprises comprehensive solutions for automated quality assurance and production process monitoring to the solar, flat glass, film and foil, converting, paper, optical media and semiconductor industries. In these areas Dr. Schenk continues to set new standards for the inspection of surfaces through the utilization of the latest technical advances in optics and electronics.

The company's primary objective is to achieve complete satisfaction of our customers on a long-term basis. This vision is realized by a perfect synergy between innovative solutions and practical ideas. Global sales and service facilities ensure local support, technical service, training and consulting at any phase of a project. From modular standard units to complex and highly customized systems – Dr. Schenk's high performance test and inspection products have precision in focus!

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