VINSPEC SOLAR
AUTOMATED OPTICAL INSPECTION FOR PHOTOVOLTAICS
Your Partner for High Performance Machine Vision Solutions

Solar is here to stay. Driven by clean energy policies and air pollution concerns, the global PV market will continue its growth well into the future. But what will that future hold for the players in PV production? In order to meet growing demand and competition, manufacturers will have to continue reducing production costs and throughput times – while simultaneously increasing product quality. And that is exactly what we do for our customers.

Manufacturers of solar cells and modules around the world look to us for automated optical inspection systems that give them a competitive edge. And with more than 2,000 successful PV installations for over 80 customers worldwide, our track record speaks for itself. We are a leading supplier of high performance machine vision solutions with 30 years of experience in industrial automation and over 10 years in photovoltaics.

VITRONIC products are state-of-the-art and guaranteed to deliver maximum benefits. In order to ensure this, we invest over 10 percent of our total revenue in research and development every year. And VITRONIC is “Made in Germany” – we develop and manufacture all VITRONIC systems ourselves. Our R&D, design and production departments are all based at our corporate headquarters in Wiesbaden, together with our administrative offices.

www.vitronic.com
The Advantages of VITRONIC
» 2,000+ PV installations for 80+ customers worldwide
» Global network and service offering
» 30+ years of experience in industrial machine vision systems
» Standard systems, customizable to customer needs
The increasing competitive pressure in the PV industry demands higher levels of efficiency and economy in order to thrive and survive. As a result, manufacturers are looking for the highest possible throughput and reliability rates in production. And there is always room for improvement. We can help you improve your yield and increase efficiency. VINSPEC SOLAR inspection systems reduce your costs per watt.

**Reducing the Uncertainty Range for a Higher Margin and Greater Efficiency**

The finely tuned inline machine vision systems of the VINSPEC SOLAR series reduce the number “false defects” detected and reduce incorrect classifications. Our technology lets you see more, giving you a smaller “uncertainty range” – providing a much clearer and narrowly defined view and classification of irregularities. With VITRONIC, the limits can be set within very small tolerance ranges. The result: less waste, more accurate classification, greater benefit and higher customer satisfaction. A broad database for the analysis of irregularities is provided. And you can learn about your process as your line works, because every measured value can be transmitted into databases or MES-systems via standardized interfaces.
THE VINSPEC SOLAR ADVANTAGES

Low Total Cost of Ownership

Reliable Defect Detection and Quality Classification
- Sorting pureness > 99.8%
- False rejects < 0.15%

Robust and Reliable Mechanical Design
- No wear parts
- Uptime > 99.5%
- Mean Time Between Failure > 16,000 h
- Mean Time To Repair < 1 h

Future Proof Solutions
- Our systems can be adapted to new or changed inspection requirements as needed by our customers, e.g. new cell designs or new classifications.

Worldwide Service and Support
Our service engineers have the expertise needed to keep your processes running smoothly. No matter where your plant is located, our expert service teams are there to provide you with comprehensive support, whenever required: on-site, per hotline or via remote access. We can support you in planning, implementation and maintenance so that you can get the most out of your production lines. Put our know-how to work for you.

VINSPEC SOLAR Versus the Competition
Our very small uncertainty ranges enable highest yield and fast ROI.

VITRONIC
- small uncertainty range
- perfect specimen accepted
- not accepted non acceptable defect
- Low risk of wrong classification

COMPETITORS
- wide uncertainty range
- perfect specimen accepted
- not accepted non acceptable defect
- High risk of wrong classification

Each dot represents the result of an inspection of one part, e.g. a wafer or cell. There is a distribution of defects that can range from perfect to unacceptable. For each inspection – e.g. finger breaks, bulges, edge defects, missing print, color – there is a different distribution of defects. The classification not only looks at individual defects, but also at agglomeration, position, or trends over several parts (heat maps).
COMPREHENSIVE INTEGRATED SOLUTIONS

VITRONIC is your partner for challenging machine vision tasks. Our passionately dedicated engineering team provides you with comprehensive solutions that can be seamlessly integrated into your production lines. Depending on your needs, you can choose from standard products with customer-specific customization or an individual tailor-made solution.

After analyzing your requirements and wishes, we offer line scan or matrix cameras combined with the most suitable custom lighting and software combination for your production setup. VITRONIC gives you the right system for your respective requirements in order to guarantee optimal results.

VINSPEC SOLAR Covers every Step of PV Production

- **VINSPEC SOLAR WIS**
  - Shape and surface inspection
  - Microcrack inspection (infrared)

- **VINSPEC SOLAR ARC**
  - Texture inspection
  - Coating inspection (camera)
  - Coating Inspection (spectrometer)

- **VINSPEC SOLAR PI**
  - Front Inspection
  - Rear Inspection

- **VINSPEC SOLAR CTS**
  - Front Inspection
  - Integrated inspection (line-scan)
  - Integrated inspection (matrix)
  - High-End combination
  - Rear Inspection

- **VINSPEC SOLAR STRING**
  - Cell inspection (before arranging in the string)
  - String inspection (position and quality)
  - Electroluminescence inspection

- **VINSPEC SOLAR MODULE**
  - End-of-line inspections
  - Electroluminescence inspection

- **VINSPEC SOLAR THIN FILM**
  - Glass inspection
  - Coating/module inspection
  - Electroluminescence inspection
We See more than Others
Much more than the sum of all its pieces. Our reputation for superior detection and classification capability doesn’t simply result from camera and illumination performance. It’s not just simply about high-resolution megapixels and the latest LEDs. The key to success is knowing exactly how to combine custom lighting concepts, camera, set-up and software into reliable solutions that let you see better. And that combination is what sets us apart from the competition.

VITRONIC: High contrast ensures reliable defect classification

The competition: Low contrast
**WAFERS**

**Inspection of Raw Wafer s**

We can help you make sure that the finishing of defective parts is a thing of the past. VINSPEC SOLAR WIS Wafer Inspection systems make sure that faulty wafers are identified, separated and rejected – as the final step in wafer production or as first step in cell lines. VITRONIC machine vision solutions can help you reduce the costs of wafer inspection, which means higher returns. Our rugged and reliable VINSPEC SOLAR WIS inspection solutions can inspect slurry and diamond cut formats and crystalline structures – mono, quasi-mono, multi-crystalline.

Depending on your needs, we offer different setups.

Raw Wafer Visible Light Inspection – checks the shape as well as the surface of the unprocessed wafer for a range of different characteristics. Inspection is carried out inline – based on the integrated structured illumination this system outperforms for topological defects.

Micro-Crack Infrared Light Inspection – scrutinizes the raw, unprocessed wafer with infrared light to reliably locate micro-cracks and other quality attributes. This system delivers the highest resolution and high throughput on the fly.
Visible Light Wafer Inspection
» Structured illumination outperforms for topological defects
» Focus: geometrical properties, including edge irregularities and surface defects

Infrared Wafer Inspection
» Highest resolution, at high throughput “on the fly”, at low cost!
» Focus: micro-crack inspection

Micro cracks

3D defects: saw marks, holes, shape defects
Cell Inspection
With our different cell inspection systems we detect relevant deviations, and we classify using various classes of color and quality. VINSPEC SOLAR machine vision systems help immediately detect and correct deviations in upstream processes such as texturing, coating, and electro-plating. They can reliably automate sorting in the cell tester for the production of high-efficiency cells.

Inspection after Texturing and Anti-Reflection Coating
VINSPEC SOLAR ARC Inspects Cells Inline for Texture and Color Deviations
These systems are designed to keep your costs low by keeping your processes on track, i.e. in the optimal range. Robust and easy to install into the automated handling system, our solutions detect deviations of reflectivity, color homogeneity and thickness of anti-reflection coating. For high-end process optimization we offer the only inline three-channel spectrometer analysis available on the market today.

Inspection after Printing
VINSPEC SOLAR PI Inspects Cells Inline for Print Defects and Surface Deviations
We can help you prevent scrap and optimize your yield. Our VINSPEC SOLAR PI systems inspect cells for printing defects and deviations inline. These solutions let you automatically ascertain print quality and scan the shape and edges of silicon cells immediately after printing. These inline systems are suited for wet prints and manage all kinds of print layouts. Direct feedback can be given to the printer PLC.

The quality feedback allows you to optimize your processes and improve quality. You can prolong the service life of the printing screens as well as reducing costs by using less silver.

Our high resolution system for front side inspection allows a reliable detection of smallest print interrupts and deviations. For the rear side we provide 5-stage illumination for best contrast and detection. That delivers unmatched performance in differentiating substrate from paste.
VITRONIC Cell Inspection Advantages
» Optimal detection performance and reliability
» Prevent scrap and optimize yield
» Inspection of up to 4,000 wafers per hour
» Inline and retrofit solutions available
» Easy installation and integration
» Robust and easy to use

Inspection in the Cell Tester
VINSPEC SOLAR CTS Inspects for Quality Criteria and Classifies Cells

Improve your sorting for higher income and higher customer satisfaction. VINSPEC SOLAR CTS Systems are designed for high performance cell classification in a cell tester. With a significantly smaller uncertainty range they ensure narrower acceptable tolerances. Thus, more cells can be accepted into a higher class – which means a higher yield for you at a minimized risk of customer complaints. The solutions allow you to ascertain quality of cells by automatically inspecting all visible quality relevant deviations. Different systems provide color, front and rear side inspections.

To best fit your needs, we offer various systems: an integrated line scan camera inspector with a small footprint, which delivers unmatched detection and classification performance in single unit. We also offer an inspection system with a matrix camera – a standstill version that is easy to install and fits all sorters. This system delivers high pixel resolution and is perfect for retrofitting into mechanics where linear and smooth movement of the cells is not easily accomplished (e.g. a walking beam). This is topped by the high-end version that combines the high resolution print inspection system with the color matrix system.

VITRONIC: Color images optimized to differentiate the color of very dark cells
Competitor: Color information insufficient for reliable evaluation of dark cells
MODULES

Cell Inspection
VINSPEC SOLAR Inspects Cells before Entry into the Stringer
Increase your efficiency and returns. VINSPEC SOLAR solutions help you automate and speed up optical inspection. We can deliver 100% inspection of incoming material on the production line based on simultaneous position measurement and quality inspection. Our system determines the cell’s position and checks each cell for corner and edge breakages, grid line interruptions, finger thickening, missing front print or surface defects prior to string soldering. Defective or fractured components can be sorted out without production delays. The system reliably detects and classifies all relevant defect characteristics. Individual warning limits make it possible to intervene quickly. Recurring defects are detected separately and may trigger a stop of the stringer.

String Inspection
VINSPEC SOLAR Inspects Strings for Position and Quality
VINSPEC SOLAR can help you ensure highest quality by inspecting the position and quality of strings. Our system reliably detects and classifies the position and contours of the cells in the string and the connections between the cells. Based on a high-resolution line scan camera with an incident light and backlight illumination the system identifies all relevant defect characteristics like position deviations, breakage and chippings, grid line interruptions and missing or twisted lead ribbons. And in combination with electroluminescence it is even able to reveal characteristics like bad efficiency areas and shunts.

VINSPEC SOLAR Covers the Entire Module Manufacturing Process:
» Quality of incoming cells
» Alignment and tabbing in stringer
» Electroluminescence quality inspection
» End-of-line inspection
Electroluminescence Inspection
VINSPEC SOLAR – String and Module Electroluminescence Inspection

You can visualize efficiency and ensure your quality characterization even more effectively with electroluminescence. VINSPEC SOLAR offers electroluminescence technology to inspect solar cells for quality and function in individual production processes – from the string to the entire module. The electroluminescence process involves stimulating the solar cell string or module using electricity. A NIR-sensitive camera then captures the cell’s pale light emissions as an electroluminescence image.

These defects can be detected:
- Inactive areas/breakages
- Inactive/hardly active cells
- Grid line interruptions
- Micro-cracks

Areas of application:
- Cell string inspection
- Cell matrix (sandwich) prior to lamination
- Cell matrix after lamination
- Complete module in the flasher
End-of-line Inspection  
VINSPEC SOLAR Inspects the Complete Solar Module  
Matrix and line scan cameras with high resolution scan the entire module width and accurately classify all relevant defect characteristics. Individual warning limits make it possible to intervene quickly. Recurring defects are detected separately and may trigger a line-stop.

Inspection of the solar cell matrix prior to and post lamination:
- Spacing between individual solar cells
- Position and function of the crossties and ribbons
- Microcracks and interrupted ribbon conductors
- Paste spots
- Changes caused by the lamination
- Laminate surface deviations
- Air inclusions, bubbles and other particles

THIN FILMS

Thin Film Module Inspection Using Electroluminescence  
Our machine vision solutions can help you reduce the costs of thin-film inspection, which means improved returns. Electroluminescence inspection illuminates your modules and helps detect inactive or defective areas. Our camera systems can detect and signal deviations within and after relevant process steps at an early stage and even help separate and reject defective parts before they enter further processing.

Thin Film Module Inspection Using Optical Systems  
With our systems different module types can be inspected inline before, during, and after the relevant process steps. They can be used for glass and coat inspection, after the individual coating and structuring processes, as well as for final inspection and classification. Special inspections such as measuring the scribe positioning help prevent downstream defects.
Software Solutions for Optimal Inspection and Classification

We develop our software in-house here at VITRONIC – as we do with all our products. We develop, manufacture and sell all of our systems ourselves. That enables us to perfectly tailor our software to generate optimal results together with the hardware in our VINSPEC SOLAR solutions, e.g. camera and lighting. Our cameras and lighting “see” extremely well, but it is our software that interprets the images – presenting you with clearly structured data that lets you optimize your production through reliable defect classification. Our cutting-edge classification algorithms ensure highly differentiated classification results that separate relevant from irrelevant effects very effectively. VINSPEC SOLAR delivers human-like sorting results with the reliability, speed and longevity of an automated solution.

Flexible Systems with a High Level of User Self-Customization

Our systems give you the flexibility you need. We provide open systems, which means you can make the changes you want yourself. All the important adjustments are supported by wizards. New cell designs can be integrated efficiently based on CAD or pattern structure or real cells. Recipe and classification wizards enable you to minimize the uncertainty range and thus to optimize your yield.

When installed, every VINSPEC SOLAR camera station within the same production share the same software and a common recipe structure. That means they can be managed at any station or via remote, giving you more flexibility. The inspection software and the graphical user interface can also be tailored to your specific requirements. The interface allows various views and a visualization of all quality relevant features for current and recently tested cells. Images and inspection results are permanently accessible at any system monitor.

Software Highlights VINSPEC SOLAR

» Suited for all present and future cell layouts
» Customizable classification levels and rules
» Reliable defect classification for process optimization
» Proven interfaces with established production equipment
» Standardized MES interface (XML, SECS/GEM)
» Local SQL database

Choose your view. The user interface is freely and easily configurable. Select from various views e.g. values, graphs, yield. Classification levels and rules are customizable.
VITRONIC WORLDWIDE

VITRONIC is a global leader in the field of industrial machine vision headquartered in Wiesbaden, Germany. Since its foundation in 1984, the privately owned company has been offering highly innovative solutions in industrial automation, logistics automation and traffic technology. Today, VITRONIC supports customers in over 60 countries via a global network of subsidiaries, service centers and partner companies.

All of the companies’ products are developed, designed and manufactured by VITRONIC in Germany. They range from standardized to fully customized solutions.

Feel free to contact us – we look forward to hearing about your projects.

Contact details and additional information, including local partner information, are available at www.vitronic.com.

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