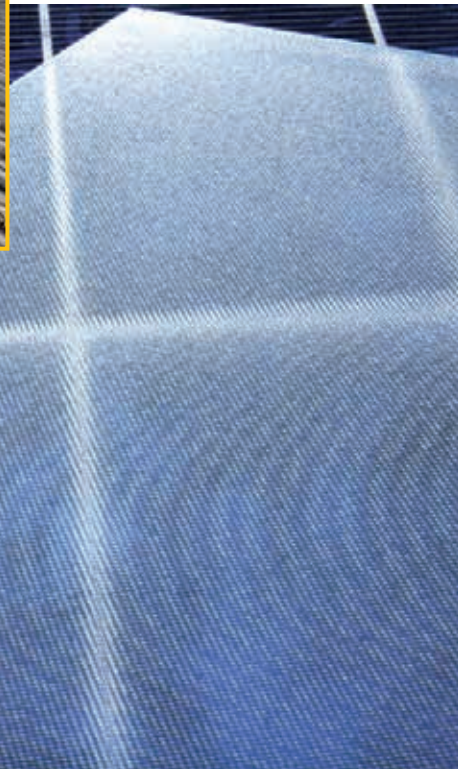
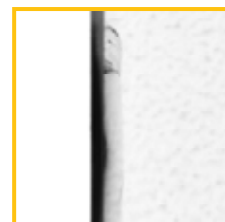
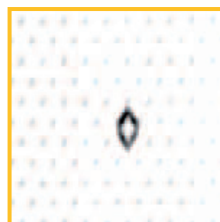
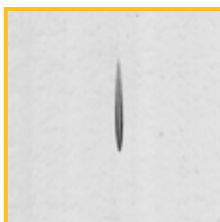


Glass Inspect



Inspection of Structured Glass for the Production of Solar Modules



GLASS AS SUBSTRATE FOR SOLAR MODULES

Manufacturers of solar modules currently use two different technologies: crystalline silicon solar cells or thin film solar cells. In both manufacturing concepts a glass substrate is placed on the modules' front side to conduct the sun light onto the cells and at the same time protect the solar panel's active layers from mechanical or chemical influences.

Whereas thin film solar modules use a standard front glass (white glass manufactured from float glass), the silicon solar modules are using a glass substrate that is structured on one or both panel sides. This structure helps to minimize the reflection of the sun light and is especially advantageous to conduct light penetrating from a slight angle. This way, the energy output of the cells can be increased.

MINIMIZE THE RISK OF GLASS BREAKAGE & ASSURE HIGHEST QUALITY STANDARDS

Like all other glass manufacturing processes, structured glass substrates are subject to defects during production. Depending on the defect type and intensity, the impact of these defects can range from



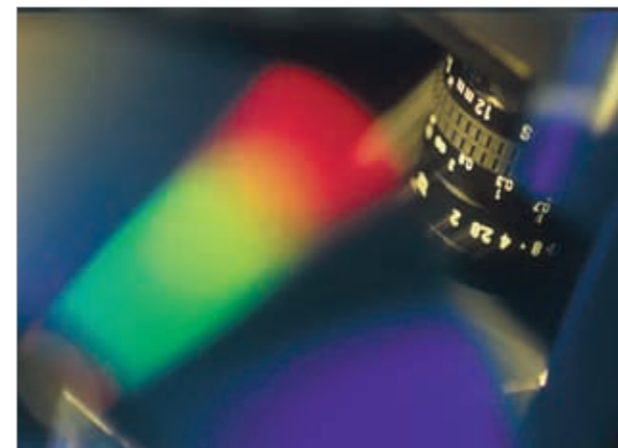
a reduced transmission to a considerable negative influence on the mechanical glass characteristics. Unfortunately, defects and contaminations are common during the production and can not always be avoided completely.

Bubbles in the glass panel, for example, induce a mechanical stress in the material that can lead to glass breakage during tempering or other processing steps. In some cases, the glass may even break at a later stage, when already delivered to the customer. Especially critical are the defects that can occur at the edges of the glass sheets – an area usually not covered by standard vision systems. Micro-cracks and chips of the solar glass panels are a major cause of glass breakage and their detection is important for assuring highest quality standards.

Besides the costs for material loss, such defects can also cause profound secondary costs such as down time of production lines or even guarantee costs. Being able to detect defects in glass panels and reject this material from further processing not only assures higher quality of the glass sheets but can also help manufacturers adjust the production process. Thus, process parameters can be corrected at an early stage and lead to higher yield.

DEFECT VISUALIZATION ON STRUCTURED GLASS

Optical vision inspection systems for quality assurance and process control are prevalent in the production of glass sheets. These are, however, mostly designed for unstructured glass. The surface structure as used for glass substrates of silicon solar modules inclines to create similar or even stronger optical signals than the actual inspected defect and is considered as the main challenge of automated optical inspection of structured glass. Where other vision systems can only deliver limited results, Dr. Schenk has developed and manufactured GlassInspect, a system specialized to precisely distinguish between glass structure and defects covering 100 percent of the material surface including the edges.

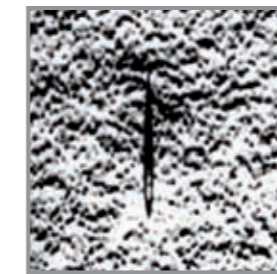


As illustrated by the grey scale images in the left column of the comparison, the defects are hard to differentiate from the glass structure. The Dr. Schenk inspection system (see images in the right column) can clearly identify the same glass defects and display them via the visualization software.

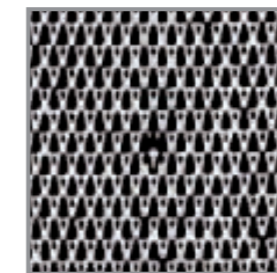
Using an innovative optical set-up, Dr. Schenk's GlassInspect can nearly eliminate all of the "optical disturbances" from the surface structure. Additional electronic filters further support and improve this technology and glass defects can be detected reliably despite the distracting surface structure.

Defect Images

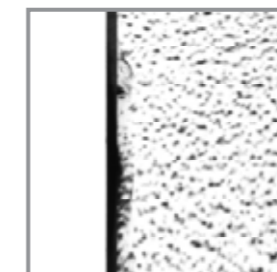
with conventional inspection system



bubble, long

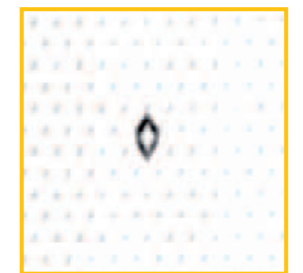


bubble, round



glass chip at panel edge

with inspection system for structured glass



GlassInspect for structured (solar) glass can be applied for both continuous float glass as well as for cut glass sheets. For sheet glass, the system also measures the panel's shape and dimensions in a parallel process using the same optical set-up.

GlassInspect

- Assures quality of the glass modules and by this supports you to meet the satisfaction of your customers
- Controls your production process and enables early corrections
- Minimizes the risk of glass breakage during further processing of the glass modules



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 optical media, flat glass, film and foil, converting, paper, solar 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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