

Surface and Edge Inspection of Flat Panels for Efficient Process Control

Inspection systems in the glass field are becoming more and more indispensable, as the sizes of glass substrates increase simultaneously with their quality requirements. The answer to these needs is given with automated surface inspection, which enables a 100% inspection after each relevant production step. On-line integration allows faster feedback in only a few seconds, and moreover, the accumulation of all inspection data compiled in a production process overview. Automated inspection systems applied in a production line are laid out to accumulate, analyze and display all inspected data on one single monitor, providing immediate process feedback to achieve a reliable process control.



Figure 1:
High resolution inspection system Chess for optical inspection of thin glass, e.g. used for flat panels

The primary requirement for efficient glass inspection is to achieve the best possible image with the highest possible contrast of the defects to be detected. An accurate selection of the illumination techniques and the imaging sensors lead to an inspection system solution, which reliably detects the defects that meet the required specification.

Which Defects can be Detected?

During the production process of glass, several incidences can happen causing defects within the glass material, like inclusions, stones, bubbles or blisters, or on the top or bottom surface, like roller marks, stains, streaks or scratches. Damages on the edges and corners of the substrate, like a breakage, crack or deformation, may also occur. The defects need to be detected and classified by the selected inspection system to find out if the substrate meets the quality requirement of the specification.

Defect Detection and Classification

There are several different methods available for the classification of detected defects on bare glass and coated glass. A common factor of all classification methods is the initial step of reducing the image information about a potential defect to a relatively small feature vector. This describes the appearance of the defect with numerical values. Commonly used features are, for example, length, width or slimness. Besides a superior image quality, efficient, complete and understandable features are the second most important step towards an accurate defect classification. A reliable defect classification is the basis to distinguish and separate critical from non-critical defects, and therefore for an efficient process control.

Solutions for Glass Inspection

Two basic technologies of illumination and sensor systems are available, based on CCD line-scan cameras and on laser scanners.

CCD line-scan camera systems consist of single or multiple line-scan cameras, combined with a special illumination unit. Even a combination with multiple illumination techniques is possible for specific inspection tasks. These line-scan cameras are comparable with those CCD-chips used in digital photography, the difference being that they consist of only one single line of pixels. These lines, with up to 8192 pixels, are exposed and read-out at a very high frequency. A continuous image of the inspected material is received by moving the glass substrate perpendicular to the scan line.

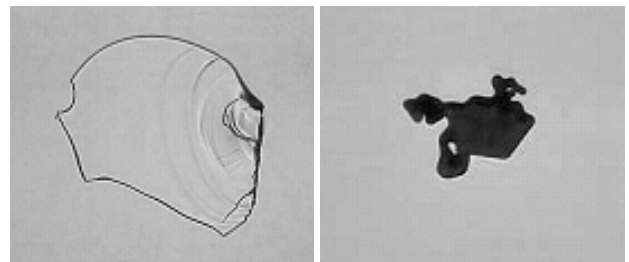
Mandatory for a successful inspection system is the correct selection of the illumination, which needs to reveal the defects to be detected, as well as to meet the required imaging quality. Dr. Schenk has developed the unique illumination unit BEAMED_LINE that is ideally suited for the inspection needs of glass material. The BEAMED_LINE illumination enables highest sensitivity and reliability for the detection of absorbing, as well as deflecting irregularities. So far, similar sensitivities could only be provided by laser scanner systems.

Laser scanner systems consist of a laser scanner head in which a laser beam is reflected off a spinning polygon mirror. This creates a scanning motion of the laser beam across the glass substrate, which starts over again as it reaches the edge of the substrate. A photomultiplier converts the received light energy into an electrical signal that is proportional to the received luminous intensity, resulting in the signal for the image.

Both of the described techniques provide convincing advantages. The correct inspection system for a given specification task can either be a single system setup, or could require a CCD line-scan camera system combined with a laser scanner to give the optimal inspection solution and best price-performance ratio. Dr. Schenk has both Laser Scanners, as well as Camera Systems in the delivery program. A comparison test, based on a specific defect list, leads to the optimum solution to a particular inspection task.

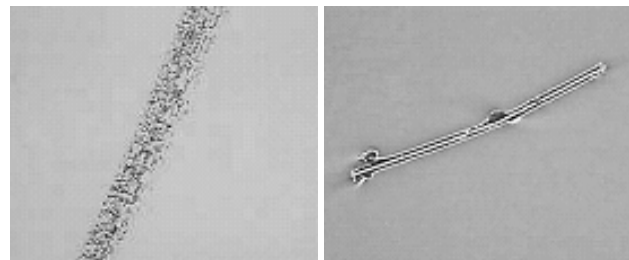
Effective Process Control

Nearly everything is possible with digital electronics today. The use of Field Programmable Gate Array (FPGA) enables the signal processing to adapt to changing requirements or to enhance it with improvements borne from experience. As an example, if inclusions near the surface turn out to produce deformations, they might be recognized by the logical combination of signals from a transmissive absorption and a reflective deflection channel. Or if bubbles always turn out to be stretched, this feature might be used to distinguish them from dirt.



Glass Chip

Metal Inclusion



Scratch

Inclusion

Figure 2: Examples of typical defects of flat panels

An effective process control can only be achieved with a 100% automated on-line inspection that immediately provides feedback on the process. The source of a defect is quickly identified with such a solution, and corrective actions to eliminate the problem can take place rapidly. In addition, the automated inspection system from Dr. Schenk provides the option to integrate additional sensors for the measurement of optical and mechanical properties. The combination of an inspection system with integrated measuring technique yields to a comprehensive solution for automated quality assurance and production process monitoring.