



## SOLAR CELL WAFER INSPECTION

Tordivel AS is a complete supplier of inline and offline inspection and measurement systems for Wafer Production. Our systems are based on long experience in wafer inspection applications.

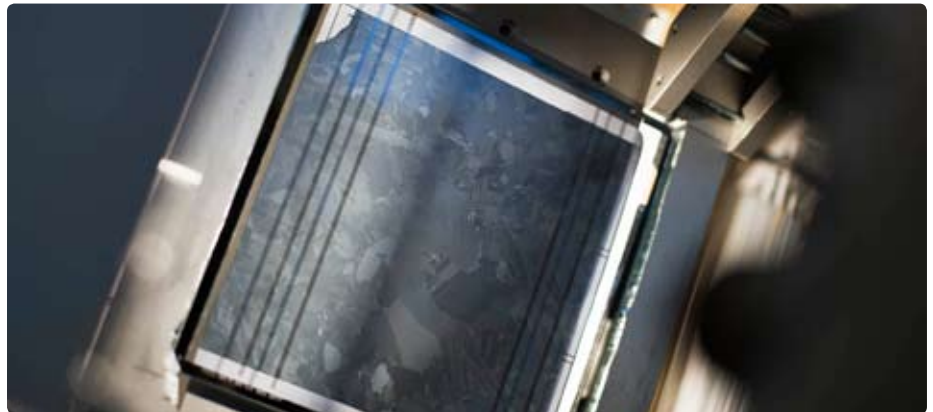
The scope is to check wafers for defects and providing measurement and sorting data. This with the highest reliability and accuracy, low maintenance cost and the best total cost of ownership.

The solutions are built on Scorpion Vision Software for user friendliness, configurability, reliability, flexibility and ease of maintenance. Off-the-shelf world class hardware components including area- and line-scan camera technology are used.



### COMPLETE WAFER INSPECTION

- Zero defects, 100% inspection of manufactured wafers
- Pre-packing inspection and sorting
- Quality control in cell production



### OFFLINE SOLUTIONS

- Sawmarks Measurement Station
- Wafer Contamination Measurement
- 3D Wafer Block Dimension Measurement before sawing
- Custom offline system

### INLINE SOLUTIONS

- Sawmarks Measurement
- Size, Surface, Chipping Edge Detection Measurement
- 3D Wafer Block Dimension Measurement before sawing
- Microcrystal Measurement
- Wafer Detection and Identification

### ENVIRONMENT

- Wafer size from 150 to 210 mm square
- Stopped or moving wafers
- Typical inspection cycle 1.0 s - designed to handle wafer rate up to one wafer per second
- Wafer speed up to 200 mm/second

### COMPLETE INLINE QUALITY CONTROL

- Sawmarks, both sides of wafer
  - 10 mm from edge
- Thickness
  - Middle of wafer and 10 mm from edges
- Chipping, both sides of wafer
  - Missing material from wafer, not all the way through to the other side
- Edge defects
  - Missing material from wafer, visible from both sides
- Glue residue
- Corner shape – length and angle of all four corner grindings
- Wafer dimensions
  - Length, width, diagonals, squareness
- Microcrystals
- Wafer contamination
- Invisible cracks



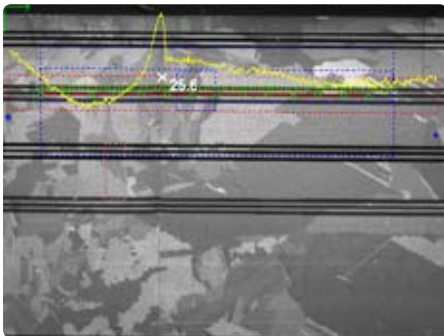
**OFFLINE SOLUTIONS**

**SAWMARKS MEASUREMENT STATION**

The offline Sawmarks Measurement System measures wafers using unique shadow measurement techniques, cancelling the effects of the crystal pattern.

The operator can verify how the sawmarks develop over the wafer. Large sawmarks will often have a large gradient towards the edge of the wafer.

- Sawmarks are measured with a profile resolution of 45 µm. This means that narrow marks with a width of 140 µm are measured.
- The maximum sawmarks detected with a 1 mm window is measured from 2 - 120 µm with 1 µm repeatability.
- Wafer size from 100 to 300 mm
- Classifies wafer in A, B and Recycle categories with user defined limits
- Scanning with user defined output



Screen image showing typical sawmark changes across a solar cell wafer. A 25.6 µm sawmark is found.

To verify online measurements, the operator can easily measure and quantify the largest sawmark on the wafer.



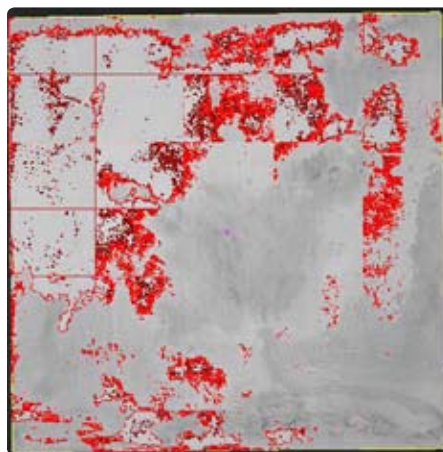
Wafer placed in cabinet fixture. The desktop robot positions the wafer under the cameras and grid.

**WAFER CONTAMINATION MEASUREMENT**

Our robot scanner measures wafer contamination. Special purpose lighting removes crystals in the image and the contamination is clearly visible on the wafer image.



Robot scanner detecting wafer contamination.



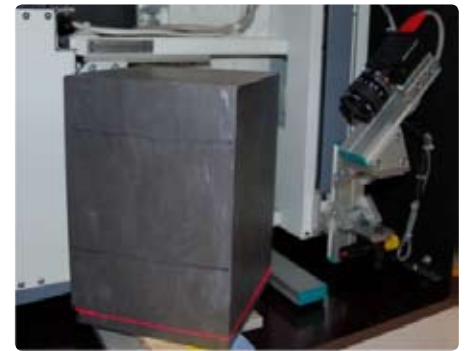
Wafer contamination detected - Contamination coverage % is measured

**3D WAFER BLOCK MEASUREMENT**

Accurate 3D models of wafer blocks are created with our 3D Scanner. The scanner is based on multiple laser triangulation profiles working in a common 3D coordinate system with the highest accuracy. A scan is fast and creates models with a resolution down to 0.01 mm.

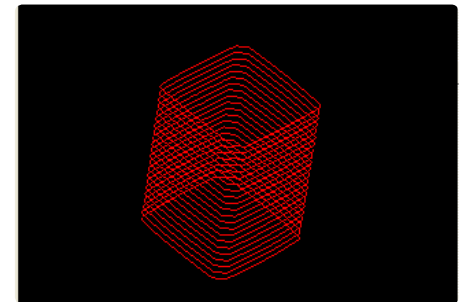
The 3D model can be exported to CAD systems.

Combining Scorpion, Firewire cameras, Lasiris lasers with Sony desktop robots and Toshiba Machine's Cartesian robots, objects up to 1000 x 1000 x 500 mm are measured.



3D wafer block scanner measuring:

- Side parallelism
- Width, height, angles
- Side flatness



3D model of wafer block

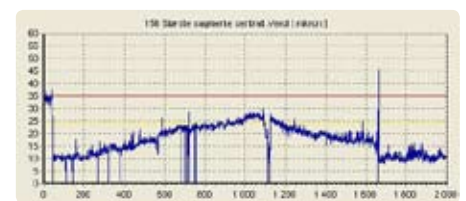
**CUSTOM OFFLINE SYSTEM**

We can make custom offline solutions based on standard components and modules.

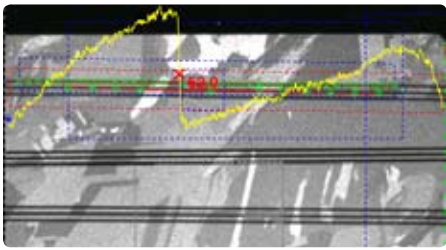
**INLINE SOLUTIONS**

**SAWMARKS MEASUREMENT**

Automatic wafer measurement is used for 100% inspection and automatic sorting. The wafer sawmark measurement system can easily adapted to be part of any production line system.



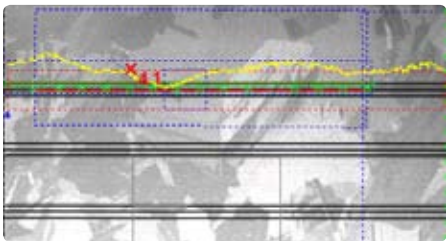
Curve on largest sawmark.



*Wafer with sawmark*

The maximum sawmark is calculated from two profiles typically 10 mm from the wafer edge on both sides. This distance is configurable online. The largest sawmark is indicated on the wafer image.

The operator can also interactively zoom in and measure the profile on the sawmark curve in the image.



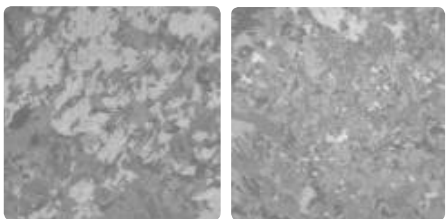
*Accepted wafer without sawmarks*

#### WAFER CONTAMINATION AND INVISIBLE CRACK DETECTION

We are scanning the wafer for contamination and invisible cracks. Special purpose lighting removes crystals in the image and the contamination and cracks are clearly visible on the wafer image.

#### MICROCRYSTAL MEASUREMENT

Microcrystals are detected if a minimum number of crystals are present within a certain area anywhere on the wafer. The wafers are classified using an advanced Scorpion texture matcher tool.



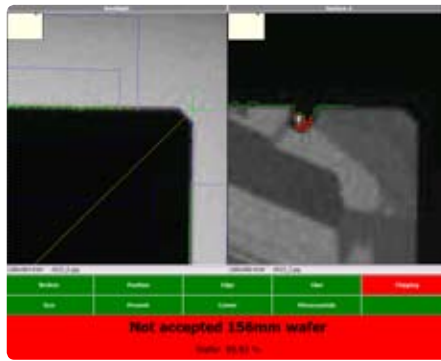
*Wafers with microcrystal*

#### SURFACE, CHIPPING EDGE DETECTION MEASUREMENT

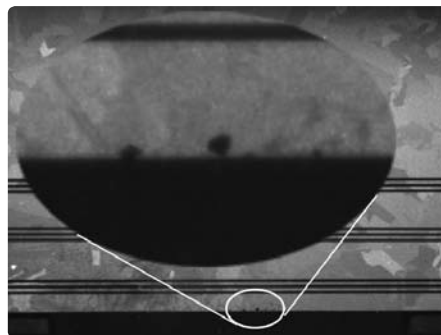
Edge defects are visible from both sides of the wafer. Chipping is missing material visible from one side of the wafer. To detect chipping we use angled lighting to make the chipping areas darker. We measure the size of the chipping and reliably reject the wafers.

The algorithms are able to distinguish shiny marks from chipping.

Our sensitivity is 3 x 3 pixels, this is about 0,1 x 0,1 mm with 40 µm pixel resolution.



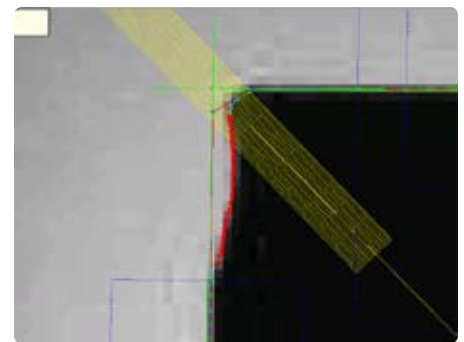
*Chipping clearly seen on the image taken with light from above.*



*Chipping close to wafer edge*



*All wafer edges are checked for defects, missing material and glue residues.*



#### Corner measurement

- All four corners are checked
- Grinding angle accuracy is 3°
- Grinding length range >0,15 mm
- Grinding length accuracy 0,05 mm
- Chipping measurement around the corner

#### THICKNESS MEASUREMENT

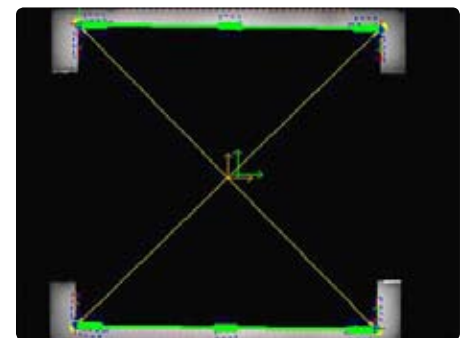
The wafer thickness is measured using angled lighting and shadowing techniques. The shadow position is measured simultaneously on both sides of the wafer. The thickness is calculated from the shadow positions both at the wafer centre and 10 mm from the edges.

#### WAFER SIZE MEASUREMENT

The wafer dimension is found based on these measurements:

- The distance between parallel edges measured in two places
- The length of each edge
- The length of the diagonals
- In case of a broken wafer, the largest usable rectangle is calculated

The resolution is better than 0,01 mm on all length measurements.



*Measuring the wafer dimension*





Tordivel as  
Storgata 20, N-0184 Oslo, Norway  
www.scorpionvision.com

#### ABOUT SCORPION VISION SOFTWARE®

Scorpion Vision Software® is an independent and open software tool for industrial vision. It is the best choice for the production engineer wanting to save cost, automate or secure quality.

The system gives the user the choice of a small form factor with the Sony SmartCam or the power of a standard PC.

Scorpion Vision Software is used in a vast variety of industries; automotive, wood, furniture manufacturing, food and drugs, robotics, packaging, energy and more.

Scorpion Vision Software solves tasks within quality control, robot vision, label and surface inspection, assembly verification, color identification and high precision gauging.

The system is founded on top of a standard Windows 2000/XP PC platform - thus a flexible alternative to proprietary vision sensors or custom vision systems.

It is cost effective benefitting from the processing power of the Intel processors, low cost - high quality firewire cameras and the possibility of connecting multiple cameras to one PC.

Scorpion Vision Software is packed with features and details making it easy to develop and maintain robust industrial vision systems.

Every single feature is specified, implemented, tested and verified based on experience obtained on the factory floor.



#### OPTIMAL WAFER LOCATION USING POLYGONMATCH™ TECHNOLOGY

Reliable wafer measurements are guaranteed with PolygonMatch™ technology used to find the position and rotation and size of the wafer with sub-pixel accuracy. Optimal location is needed for high precision measurement and defect detection.

#### FLEXIBLE INTERFACES

- TCP/IP, RS-232, Profibus or other industry standard interfaces for delivery of inspection results and system status
- OPC support
- Logging of inspection results
- Statistics presentation - Pareto Graphs

#### EXISTING SYSTEMS

The wafer inspection systems are based on the third generation, 100% automatic quality control systems running at REC Wafer's plants in Glomfjord and at Herøya, Norway, since 2001.

Based on Scorpion Vision Software®.  
Supplier: Tordivel AS.



*The cabinet contains a complete wafer inspection system with desktop robot, cameras, illumination, wafer fixture and computer running Scorpion Vision Software®.*

*Online Configuration and Maintenance*

*For more information:*

Tordivel AS  
Phone +47 2315 8700  
Fax +47 2315 8701  
office@tordivel.com  
www.scorpionvision.com



#### SPECIFICATION OVERVIEW

PARAMETER	
Sawmark accuracy	1 µm
Thickness (TTV)	1 µm
Chipping	0,1 x 0,1 mm
Edge faults	0,1 x 0,1 mm
Glue residue	0,1 x 0,1 mm
Dimensions	0,05 mm

Scorpion Vision Software® is a registered trademark of Tordivel AS.  
PolygonMatch™ is a trademark of Tordivel AS.