Project Partners:

SCANLAB AG
InnoLas Systems GmbH
Institut für Solarenergieforschung, Hameln

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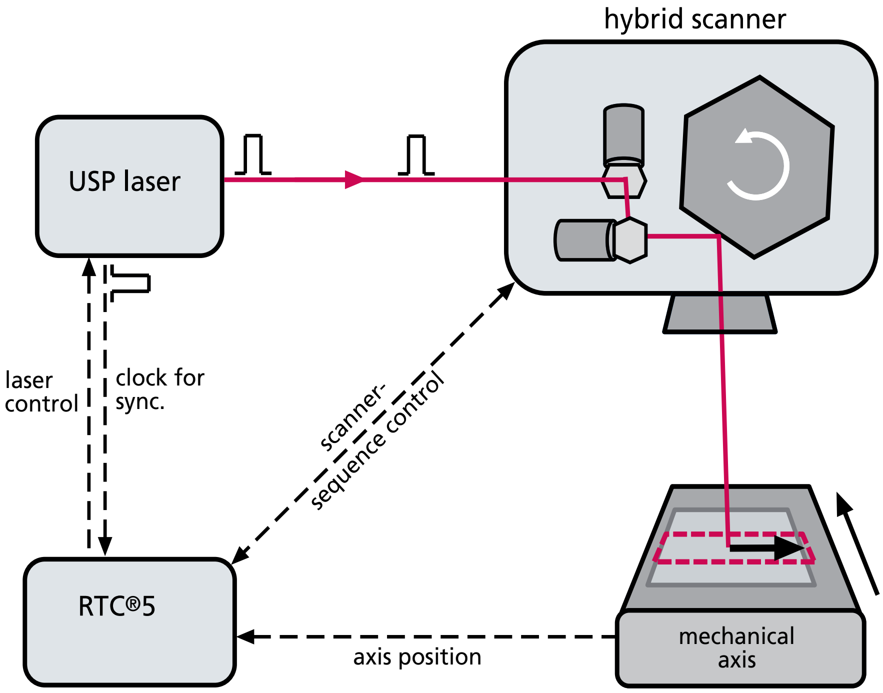


High-Dynamic-Performance Laser Scan System Developed for Processing of Silicon Wafers

Project Overview

Ultralas research project partners Innolas Systems and SCANLAB developed a demonstration system for precise, high-throughput USP surface processing of crystalline silicon solar cells, which was subsequently tested for process development by the Institute for Solar Energy Research (ISFH) in Hameln, Germany. The demonstration system relies on SCANLAB-developed hybrid polygon galvo scanners which enable seamless integration into the overarching system thanks to an innovative control approach that presents a straightforward interface to the user.

Principle: High-Throughput Raster Processing

SCANLAB optimized its polygon scanner system for highest scan speeds and accuracy in line-by-line surface processing of workpieces via high-repetition ultra short pulse (USP) lasers.
The hybrid scan system employs a rotating polygon mirror for fast line scanning. Also utilized are two galvanometer scan axes that permit compensation of polygon mirror inaccuracies as well as image field correction and enlargement of the working area so that scan lines may be positioned in a strip window. This ensures a precise, high-quality processing raster even under high-throughput conditions.
SCANLAB's RTC®5 control board software facilitates easy implementation of the typical application: here the system is combined with an external mechanical feed axis for continuous processing of a large-surface workpiece in processing-on-the-fly mode. Processing can be full-surface or via user-defined bitmap patterns.
Built-in synchronization functionality enables the scanner control to track the laser source's external clock, making the system ideal for applications employing modern USP lasers.

Optics

The usable scan field is strip-shaped and aligned to the polygon wheel's direction of scanning.

The optical design permits a variety of F-Theta objectives to be used.

The project employed an objective with a 250 mm focal length, coated for picosecond lasers in the green spectral range. Meanwhile, systems for the 355 nm and 1064 nm wavelengths have also been built.

Combining with External Feed Axes

With the aid of an external feed axis moving perpendicular to the polygon wheel's scan direction, a long area can be processed across the scan field's entire width.

Here, the scan field's strip width in the feed-axis direction is available as the correction area for speed compensation, which occurs automatically via sequence control during raster marking.

Control

The system is controlled by an RTC®5 board in conjunction with special software. Users have access to a special DLL library providing an interface to the scan system's functionality.

Bitmap Processing

The scanner is typically used for full-surface processing in a regular raster. Individual exposure patterns can be produced via a function that allows outputting a user-defined bitmap for pixel-accurate control of the processing laser.

Polygon Correction

A unique feature of this scan system is the built-in automatic correction of typical deviations inherent to polygon scan systems. These include uneven scan speeds within the working field due to lens distortion and imperfections in polygon wheel symmetry. Correction occurs via the system's two galvanometer scan axes and is performed automatically by the RTC®5 control board.

Workpiece Position Correction

Minor positioning errors, such as workpiece displacement or rotation, can be compensated automatically via the scanner's correction axes. The Ultralas demonstration project's system concept envisions an image processing station for recognizing the wafer's position.

Synchronization Functionality

Ultra short pulse lasers normally used with this system are typically equipped with an internal clock source that regulates the time points of possible laser emission. The system's firmware provides a special synchronization and correction mechanism to ensure precise and even processing rasters even in this situation. The result is attainment of processing accuracy substantially finer than the pixel spacing. This is particularly vital for applications requiring spatial separation of single pulses or identical repetitive processing.

Demonstrator Specifications

Aperture	8 mm
Wavelength	514 / 532 nm (1)
Average laser power	30 Watt
Grid dimension (2)	
in lines	typ. 50 µm (adjustable)
in columns	typ. 50 µm (adjustable)
Repetition rate	800 kHz – 3,7 MHz
Typical line frequency (3)	approx. 800 Hz
Processing width (2) (4)	158 mm
Line speed (2)	40 – 180 m/s
Duty-Cycle (full width)	approx. 68%
Correction area (2) (cross to scan direction)	10 mm
Precision (2) (raster absolute)	approx. ±15 µm (5)
Wight	approx. 19.5 kg

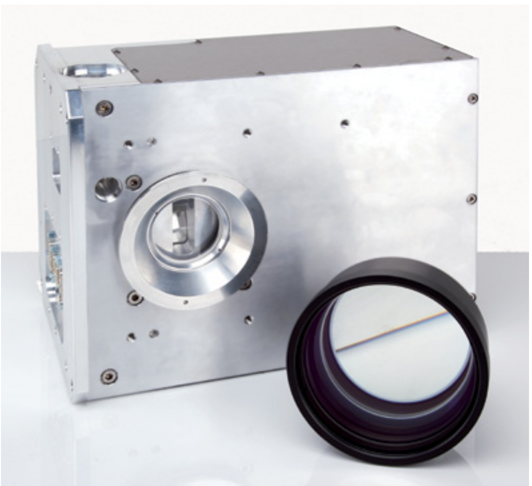
(1) 355 and 1064 nm also available

(2) with f = 250 mm

(3) with a grid dimension of 50 µm and a repetition rate of 3,7 MHz

(4) with 8 mm aperture

(5) with optimum correction



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