

## NEWSLETTER

### **(1) Advanced LumiSolarProfessional (LSP) Inline System now available**



LSA automation and greateyes announce the introduction of an advanced LSP Inline inspection system for pre-laminates and solar modules. The term "advanced" refers to the fact that the tool is not only capable to detect micro cracks, low intensity cells and contaminations, it also determines misaligned bus bars, rotated solar cells and other quality issues. Moreover the LSP Inline system exhibits a fast cycle time below 30sec including feed-in, inspection, automatic defect recognition, pass/fail decision and unloading. The unique design of the tool provide significant higher throughput and analysis power compared to conventional in-line EL inspection tools. Precise quality control, higher yield and cost savings are the main reason for implementing the machine in the production line.

In contrast to other vendors the new inspection system uses two scientific greateyes cameras in combination with high-throughput objectives allowing for fast detection of the weak electroluminescence. Furthermore an innovative automatic image analysis software provides superior performance in the detection of failures within pre-laminates or solar modules. The mono- or polycrystalline silicon based substrates are characterized with sunny-side down. Inspection of thin-film modules is available on specific request.

**General specifications**

System	Turn-key Electroluminescence In-line Inspection System
Substrates	Pre-laminates and solar-modules
Cell type	mono- and poly-crystalline silicon, thin-film on specific request
Max. module size	2.0m x 1.0m
Complete cycle time	26sec
Nominal throughput	138 modules/h
Dimensions of the tool	2200mm x 2200mm x 1400mm (w x d x h)
Certification	CE

**Electroluminescence Imaging Subsystem**

Camera type	2 x Scientific CCD Cameras, Model: GE 2048 2048 FI
Pixel size	13 µm
Full Well capacity	100000 e <sup>-</sup>
Readout Noise	4e <sup>-</sup>
Dynamic range (ADC)	16bit
Resolution	500µm (8MPixel)
Image acquisition time	15 sec.
Module power supply	0..150V, 0..10A

**Automatic Image Analysis Software**

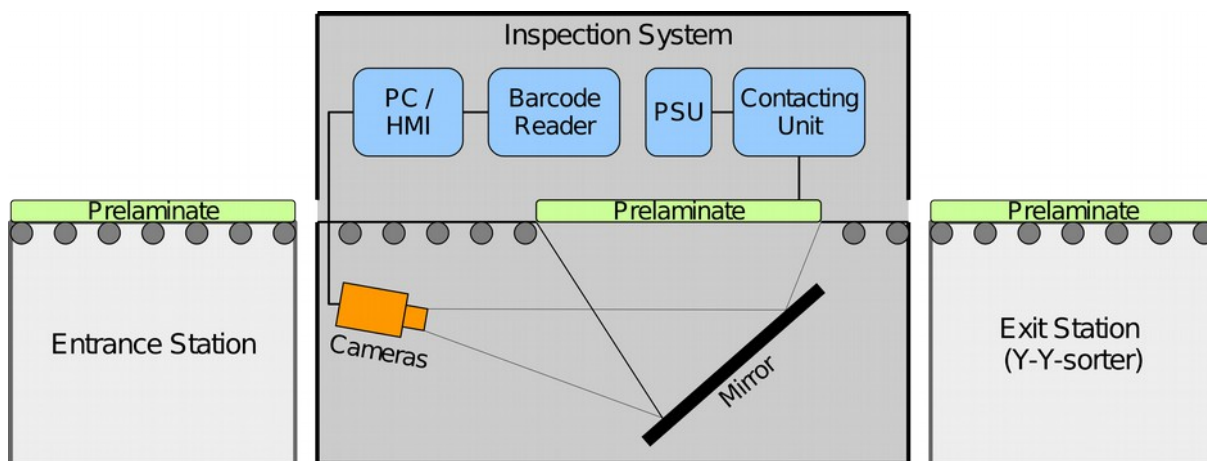
Computer Hardware	Industrial PC
Defect Recognition	Cracks / Inactive cell areas Micro-cracks Contaminations Low intensity cells Inactive (dead) cells Edge defects (border decline / edge isolation) Misaligned busbars Misaligned / Rotated cells
Receipe definition	yes
Operator/Engineer Levels	yes
Pass/Fail decision	yes
Data export	tif, bmp, jpeg

Read more :

### (a) Principle of operation

A transport system automatically moves the pre-laminate into the inspection system via two lateral slim belt conveyors and a central support-wheel. Once the pre-laminate has reached its final position, secondary supports are deployed across the long sides of the pre-laminate and the support wheel is removed.

After positioning the electrical contacting is performed and the electroluminescence measurement starts. In a first step the photovoltaic cells on the pre-laminate or module are forward biased and the resulting electroluminescence emission is recorded using two low-noise, NIR sensitive scientific CCD cameras. The imaging process is performed by taking two partial images of the pre-laminate. Once finished, the automated defect analysis is started and defect patterns are recognized, categorized and their severity is evaluated based upon predefined adjustable thresholds. Simultaneously, the electrical contact is released, and the pre-laminate is moved out of the chamber while feeding in the successive unit for inspection.



*Figure 1: Schematic illustration of systems key components*

After the defect analysis of the first pre-laminate has been terminated, the analysed images are stitched together by the software and all potential defects found are visualized for the operator. A corresponding digital signal is given to the material flow control about the pre-laminates overall quality status (NOK, OK). A sorter and roller transporters at the exit station have to forward the pre-laminate for further processing (laminators) or to fast-repair stations, accordingly.

### (b) EL inspection system composition

The electroluminescence inspection system (ELIS) consists of an imaging unit which comprises of two low-noise NIR-sensitive scientific CCD cameras and a mirror for folding the optical path in order to reduce the required overall system dimensions. The inspection system is designed to characterize pre-laminates with substrate sizes up to 2000 mm × 1000 mm. The total image size is 2048 × 4096 pixels which results in an effective EL image resolution of approximately 500µm/Pixel.

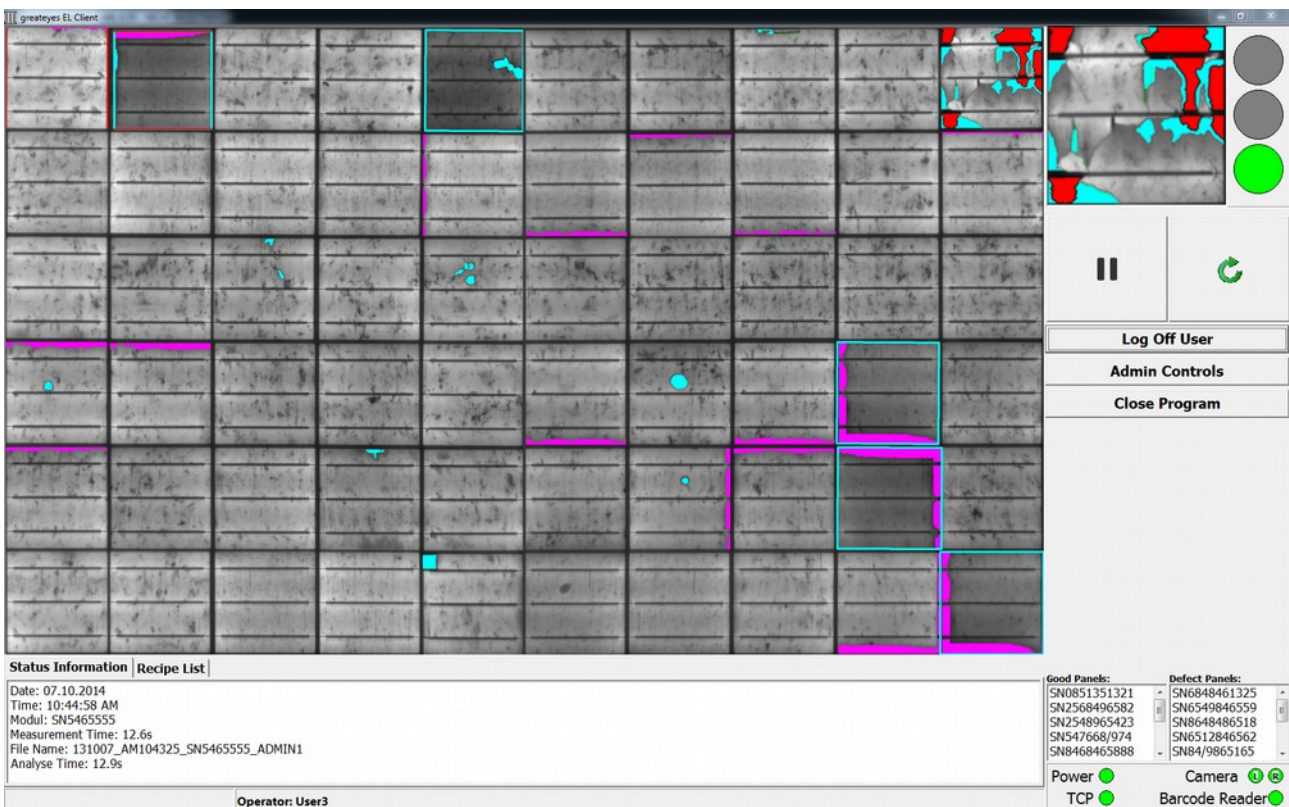
A programmable DC power supply is used to induce the EL emission of the photovoltaic cells. The outputs are only activated during the imaging process of the cameras. The actual characterization of pre-laminates via the analysis of the measured EL images is performed on a high-performance industrial PC system that is also employed to steer the overall system functions and to provide human machine interfaces (HMIs) for system operation and control.

**(c) Automatic defect analysis software**

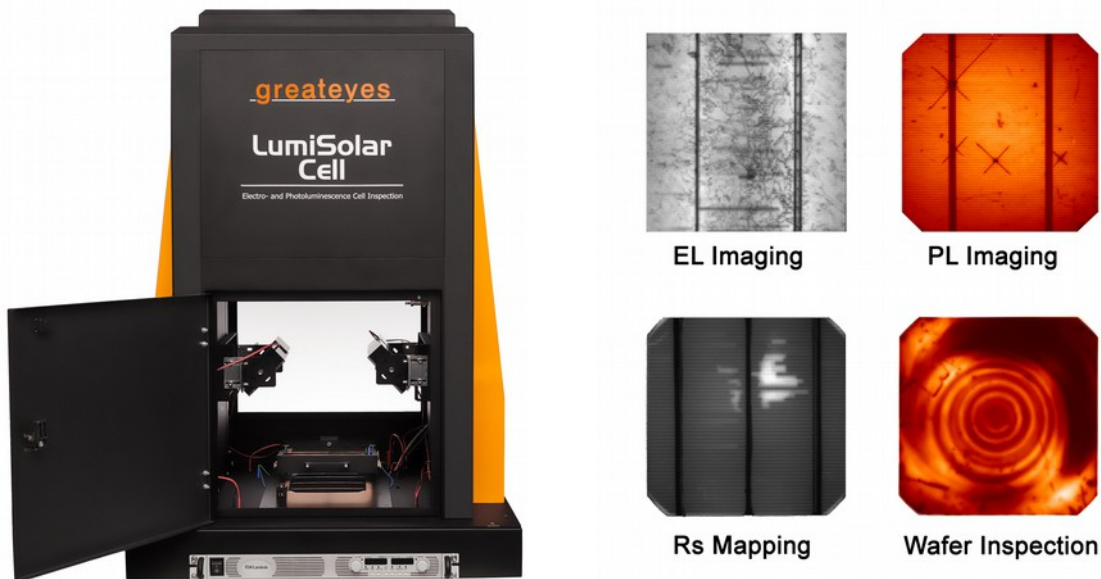
The analysis software automatically identifies, analyses and classifies a variety of common defect types which are described above. With the automatic detection of defects a detailed quality control is provided.

Recognized defects:

- Cracks / Inactive cell areas
- Micro-cracks
- Contaminations / low intensity areas
- Low intensity cells
- Inactive (dead) cells
- Edge defects (border decline / edge isolation)
- Misaligned busbars
- Misaligned / rotated cells



## (2) Next generation of LumiSolarCell system with additional features launched



The LumiSolarCell HighPower LED based system for EL and PL measurements of solar cells and wafers is now available as an advanced version and offers a variety of new features.

The adoption of a 4-quadrant power supply enables the advanced system to measure series resistance as well as measurement of the local cell voltage and mapping of the local current density. Additionally, biased PL and minority carrier lifetime mapping can be performed.

With an optionally available thermography camera detection of hot spots in solar cells are possible. Furthermore, the new developed EL adapter enables a customer-friendly and easy change between PL and EL measurements. The flexible design allows EL measurements for solar cells with 2-5 bus bars.

Compared to other PL systems, the LumiSolarCell provides a unique approach to the world of PL inspection: instead of a laser, an innovative HighPower LED light source is utilized for excitation. We improved the LED alignment to achieve homogeneities even better than >90%.

The LumiSolarCell system is an indispensable tool for modern and involved solar research. The knowledge gained through measurements will lead to increased product quality and higher yield.

### General specifications

System	Innovative HighPower LED-based PL, EL and IR inspection system
Substrates	Solar cells and wafers
Cell type	Mono- and poly-crystalline silicon, amorphous silicon, CIS, CIGS, CdTe, and HIT
Max. substrate size	200mm x 200mm
Characterization methods	<u>Electroluminescence</u> : EL and reverse-biased EL imaging, series resistance, mapping of the local current density and of the local cell voltage <u>Photoluminescence</u> : PL imaging, biased PL, Minority carrier lifetime mapping <u>Thermography</u>
Dimensions of the tool	715mm x 600mm x 1120mm (w x d x h)

### PL and EL Imaging system

PL light source	HighPower LED array / Adjustable intensity, max. 1500W/m <sup>2</sup> (>1 Sun) / Homogeneity >90%
EL excitation source	Programmable power supply (V+, V-, I+, I-), 0 to +/-20V, 0 to +/-10A
EL contacting adapter	Adapter for 5 and 6 inch cells (156mm x 156mm) included Flexible design for 2-5 bus bars Vacuum contact adapters for IBC cells available as an option
Image size	1024 x 1024 or 2048 x 2048 pixels, both 16 bit
Image resolution	150µm/pixel or 80µm/pixel
Typ. exposure times	0.1 sec-10sec depending on the substrate and type of measurement
Options	Thermography

### Features of the LumiSolarCell system

Inspection capabilities	Micro-cracks / Dead or broken cells / Shunts / Finger defects / Paste properties / Local lifetime / Hot spots / Inhomogeneities and impurities
Areas of application	Inspection of wafers, processed solar cells and thin film substrates Research and development Characterization and qualification Failure analysis Identification/sorting of wafers & cells

## Upcoming Exhibitions

Get in touch with greateyes and its products during the following events:

2014 International Workshop for EUV and Soft X-ray Sources  
3<sup>rd</sup> – 6<sup>th</sup> November 2014  
Dublin  
Ireland

6<sup>th</sup> Joint BERII and BESSY II User Meeting  
4<sup>th</sup> – 5<sup>th</sup> December 2014  
Rudower Chaussee 17  
12489 Berlin

## Presentations & Product Demonstration

Currently we are offering a cost-free talk about : "Electroluminescence and Photoluminescence Inspection Systems". If you are interested integrate our presentation into your group meeting or related scientific event please get in touch with us. In case you are interested to test the greateyes inspection systems together with your application, please send a request as well.

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