



SolR®

SolR® is an in-line monitoring system for PV thin-film application which provides the key parameters of each layer during the process. It is available for CIGS and CdTe based thin-film solar cells and is compatible with typical in-line and roll-to-roll processes.

SolR® features

In-line control of film thickness and optical properties of each layer - TCO, absorber and buffer layers - during in-line and roll-to-roll PV thin-film production processes:

- multiple thickness line scans of critical layer (absorber, buffer, TCO) without extra handling steps
- monitoring of effective absorption
- conductivity fingerprints
- roughness and texture

Communication / integration

SolR® is designed to be compatible with typical state of the art in-line and roll-to-roll processes and to work on all major types of substrates and current PV cell designs.

The system can be interfaced to a wide variety of production machines by virtually any standard interface (see below). We offer the ideal way for the customer based on the capabilities of the production equipment and the desired information. Specific software / hardware interfaces can be implemented based on 5V TTL or 24V voltage/current on request.

Typical accuracy of thickness measurements

- absorber: 1000 – 6500 nm \pm 1 %
- buffer: 30 nm \pm 20 % – 500 nm \pm 5%
- TCO: 30 nm \pm 10 % – 500 nm \pm 5%

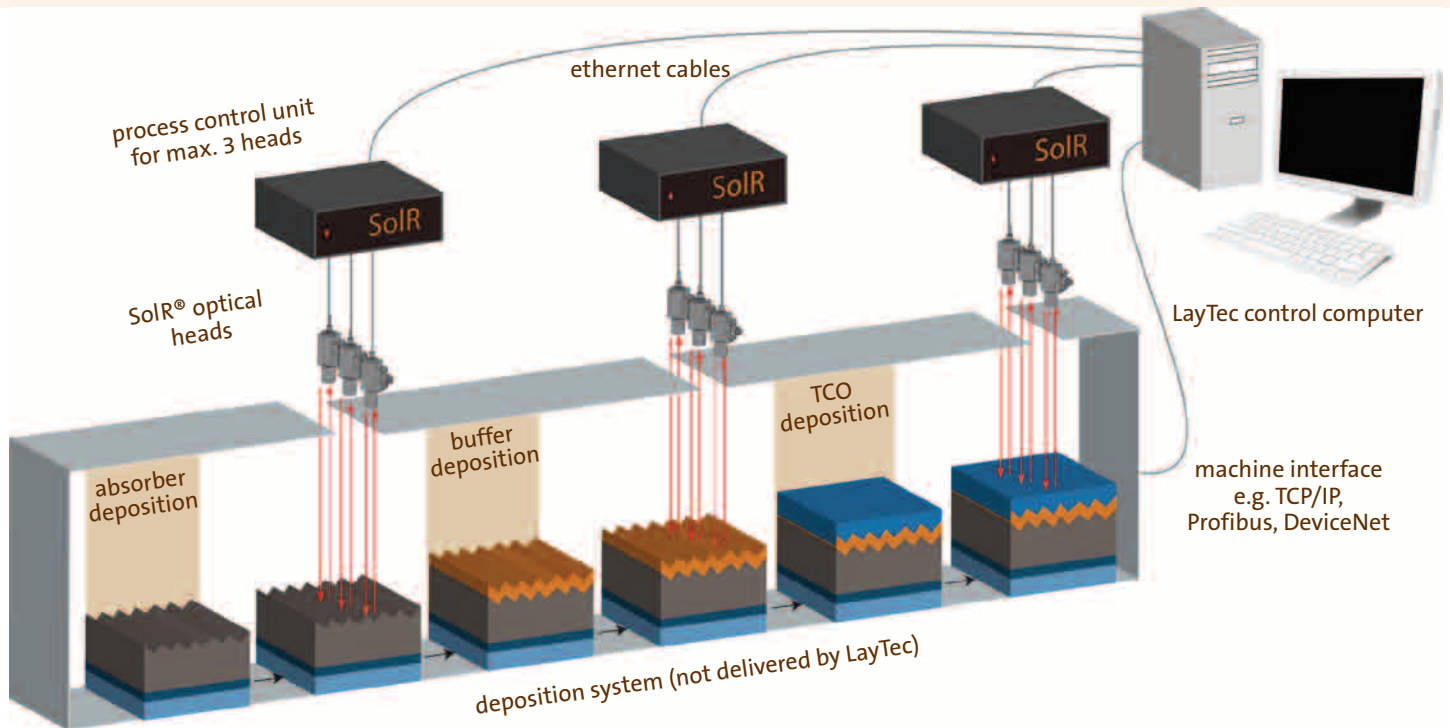
The process

Measurements are carried out after each layer deposition at up to three position perpendicular to the running direction of the substrate. Though the process described here uses a metalized substrate, the SolR sensors can also be used in production processes on transparent substrates (superstrates). The information on TCO, buffer and absorber is then obtained in reverse order.

SolR® is capable of measuring both in in-line production lines and on roll-to-roll coaters.



SolR® standard package



Details of the set-up: Reflectance measurements on each layer

The figure above illustrates the use of the SolR®-System in a CIGS-PV process based on a metalized substrate.

At the first station IR-reflection spectra of the absorber are taken. Spectra are analyzed in the infra-red (IR) range where the absorber is transparent and spectra show a characteristic interference pattern to yield the thickness of the layer.

The second measurement is performed after the buffer deposition. The add-layer cause a shift of the interference pattern, which is analyzed to reveal the buffer thickness. For an accurate thickness determination, however, it is essential to know the thickness of the underlying absorber at the same spot where the current spectrum is taken. Hence, the data analysis is performed in a central control computer where data from all stations are collected.

Finally, the TCO thickness is measured by vis/IR-reflectance measurement after TCO deposition. Since the TCO is transparent in the visible range of the spectrum, vis-reflectance can already reveal the layer thickness. However, thorough data analysis can even reveal information on free carrier absorption from IR spectra in order to characterize the conductivity of the TCO in-situ.

Optical heads

light source	halogen lamp
typical life-time according to manufacturer	10.000 h
reflectance measurement wavelength and bandwidth	500 - 1650 nm depending on the layer to be measured
measurement interval	1 s

SolR® standard package

Process control unit

The control unit is a standard 19" case that contains the light source and processes the data measured by the optical heads (max. 3 heads per unit). The control unit is connected with the control computer and the deposition system as shown in the drawing above.

Control computer (subject to technical changes)

- 19" rack mount control computer
- CPU: Pentium Core 2 Duo, min 1.66 GHz, RAM min. 1 GB
- HDD min. 160 GB, RAID 1
- DVD-writer, card reader, mouse, keyboard
- 100 Mbit/s LAN interface or better
- operating system: Windows XP pro MUI (multi language version)
- 19" TFT flat screen (monitor resolution of 1280 x 1024 or higher)

Cables

- 2 optical fibres per head (optical head <-> electronic unit): 10 m, core diameter - 600 µm, special vis-IR transparent material, minimum bending radius 36 cm
- ethernet Cat5 + TP cable
- optionally, a KVM extension set (cable or ethernet based extender) is available
- multi-plug and power cables

Miscellaneous items

- specific mounting and adjustment unit
- manual and software CD

Interfacing Option

LayTec can offer the following options:

- ProfiBus
- DeviceNet
- OPC
- Straight Wiring: connecting analog or digital signals via wire pairs as the simplest way of interfacing. Available are 24 V current loops (4-20mA) or voltages (0-10V) (only very limited information transport is possible)
- other options on request, e.g. LightBus, EtherCat, CANBus, ModBus, InterBus.

Sizes and weights of the parts

Parts	Size X x Y x Z mm	Weight, kg
SolR® optical head	50 x 100 x 150	0.5
control unit (19" case 4 HE, 84 TE)	450 x 600 x 180	12.0
control computer or rack mount control computer (4 HE)	430 x 500 x 180	13.0
19" LCD display	410 x 20 x 420	5,5
mounting and adjustment unit	system specific	ca. 2.0

SolR[®] requirements

Requirements to the deposition system

- standard normal-incidence optical view ports; customized solutions with two optical heads for other angles of incidence available on request
- or
- direct optical access “through the air” between deposition steps
- depending on the deposition system, feed-throughs for two optical fibers, if necessary (feed-through plate for KF40 is available)

Operating conditions

Component	Allowed temperature range	
	operation	storage
optical head	10°C – 40°C	10°C – 60°C
electronic control unit	10°C – 35°C	10°C – 60°C
control computer	10°C – 35°C	10°C – 60°C

Please note:

- vibrations of optical head have to be avoided during the measurement
- optical head is fragile, avoid shock-treatment
- warm-up time: <15 min

Electrical connections / power consumption

- the main connection (100-240 V) including extension cables to the control unit has to be provided by the customer
- input voltage: 100 - 240V AC wide range
- the power supply must be equipped with grounding wire
- power consumption (typical values for 230 V operation):

Component	current / A	power /W
	typical	typical
control computer	0.5	115
monitor	0.3	60
control unit rack	0.3	60
sum	1.1	235

Availability

SolR[®] can be adapted to virtually any PV thin-film deposition system. It is designed to be compatible with typical in-line and roll-to-roll processes and all major types of substrates and PV cell designs.