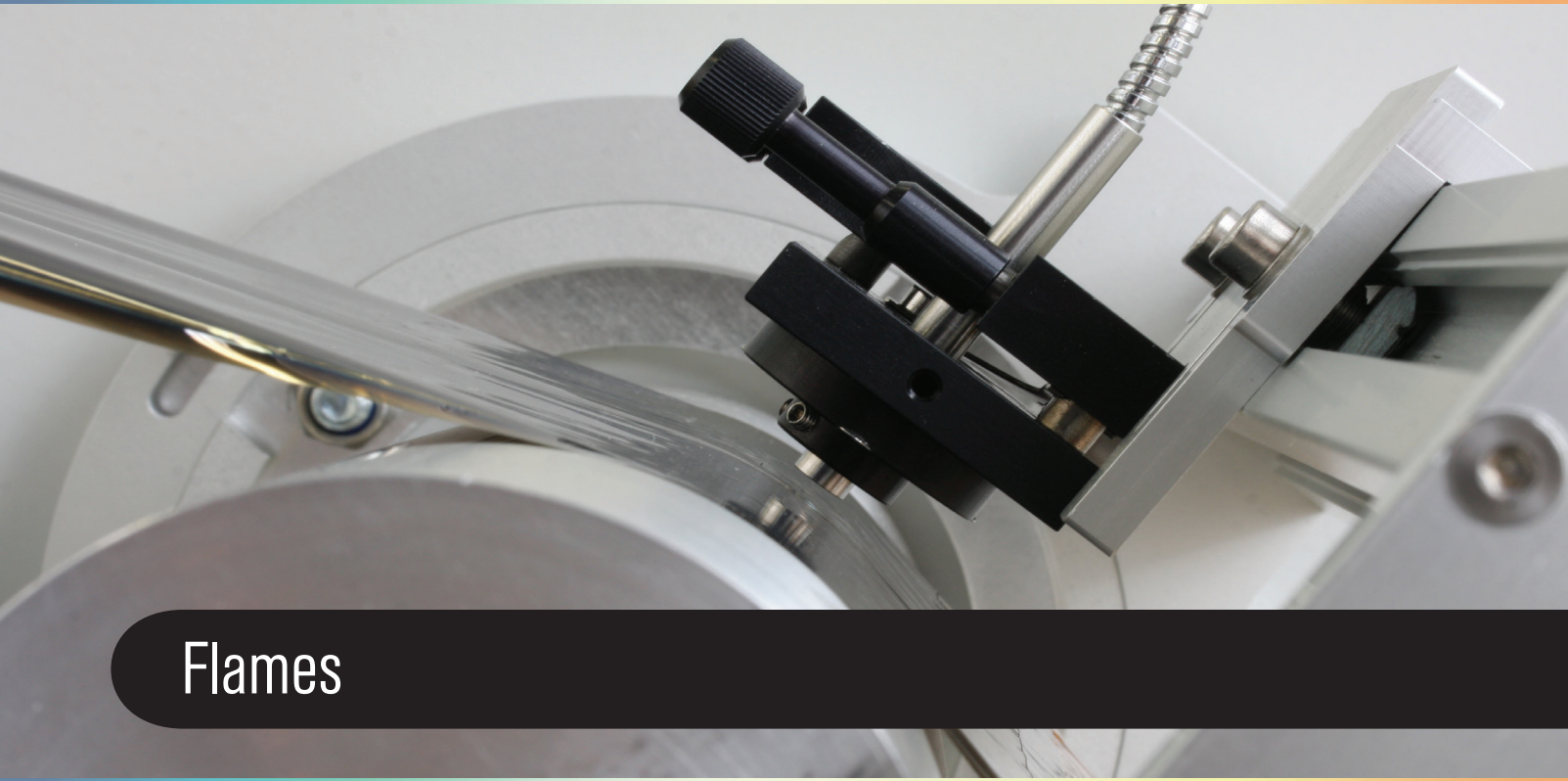




Flames

Flames IR is an in-line monitoring system for PV thin-film applications which monitors 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. Though the system is designed for thin film PV applications, it can be customized for many other large area coating processes on request.

Features

Measurement parameters

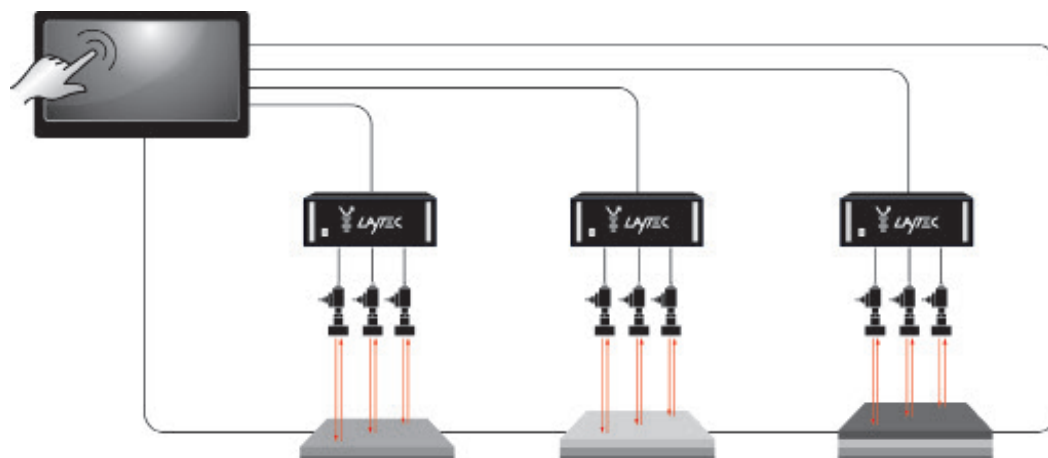
Flames IR offers in-line control of film thickness and optical properties of each layer - TCO, absorber and buffer layers - during in-line and roll-to-roll PV thin-film production processes:

- Multiple thickness line scans of critical layers (absorber, buffer, TCO) without extra handling steps
- Monitoring of effective absorption
- Color monitoring
- Adaptable to every in-line process via customized optical heads and mounts
- Spatially resolved thickness measurements through multiple heads
- Fast data acquisition for in-line measurements on moving substrates
- Automated film thickness analysis (incl. algorithms for rough layers and LayTec dispersion database for all PV materials)

Benefits

Flames IR 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.

Details of the set-up



Flames IR system used in a CIGS-PV process

The Flames IR monitoring system is based on specular spectroscopic reflectance measurements. It is designed for a perfect in-line control of all thin-film PV processes. Flames IR is available in various editions for copper indium gallium selenide (CIGS), cadmium telluride (CdTe), amorphous microcrystalline Si and organic material based thin-film solar cells. Set-ups for roll-to-roll applications are available as well.

At first, IR-reflection spectra of the absorber are taken.

The second measurement is performed after the buffer deposition. 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 after TCO deposition.

However, the 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	450 - 1650 nm
Measuring spot size	5 mm diameter
Wavelength and bandwidth	Depending on the layer to be measured
Typical measurement interval	0.3 s

Accuracy

Absorber	1000 - 6500 nm $\pm$ 1 %
Buffer	30 nm $\pm$ 20 % – 500 nm $\pm$ 5%
TCO	30 nm $\pm$ 10 % – 1000 nm $\pm$ 3%

Description of the parts

Process control unit	The control unit is a standard 19" case which 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. Additional sensors, like light barriers, ultrasonic sensors and angle sensors can be connected to the control unit to trigger measurements and synchronize with substrate motion.
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) - Optional: touch screen monitor
Cables	- 2 optical fibres per head, connecting optical head and 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 options offered by LayTec	- 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 - 20 mA) or voltages (0 - 10 V) (only very limited information transport is possible) - Other options on request, e.g., LightBus, EtherCat, CANBus, ModBus, InterBus

Sizes and weights of the parts

Part	Size X x Y x Z mm	Weight in kg
Flames IR optical head	50 x 100 x 150	0.5
Control unit (19" case 4 HE, 84 TE)	450 x 600 x 180	12.0
Mount control computer (2 HE)	440 x 792 x 86	24.0
19" LCD display	410 x 20 x 420	5.5
Mounting and adjustment unit	System specific	Ca. 2.0

Requirements

- 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	Temperature range (°C)	
	Operation	Storage
Optical head	10 – 40	10 – 60
Electronic control unit	10 – 35	10 – 60
Control computer	10 – 35	10 – 60

- Vibrations of optical heads have to be avoided during the measurement
- Optical heads are fragile, avoid shock-treatment
- Warm-up time: < 15 min

Electrical connections / power

- The main connection (100 - 240 V) including extension cables to the control unit has to be provided by the customer.
- Input voltage: 100 - 240 V 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
Control computer	0.5	115
Monitor	0.3	60
Controller	0.5	120
Total	1.3	295

Specifications are subject to further technical development and may differ from those given in the data sheet. In certain cases, performance may be limited by reactor type and/or growth conditions. Please consult our technical sales team to see how LayTec metrology can best serve your specific application.

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