

EpiR DA UV TT

EpiR DA is an in-situ sensor for thin-film growth monitoring. Based on a detector array, it provides a full spectroscopic measurement of the normalized and absolute reflectance. EpiR DA UV is the configuration with ultraviolet (UV) spectroscopic range for GaN and oxide applications. Additional True Temperature (TT) module for temperature and reflectance measurements is available on request.

EpiR DA UV TT features:

Reflectance measurements

- fast full spectroscopic reflectance measurements
- time resolved spectroscopic measurement mode (color plot mode)
- wafer selective growth rate fits using virtual layer approach
- true reflectance measurements in the full spectral range

Temperature measurements

- fast wafer selective true temperature measurements, pyrometer calibrated against a black body radiation source (only with TT module)
- EpiSense control and analysis software
- optical wobble compensation included
- measurements on single and multiple wafers, supporting planetary susceptor
- wafer selective measurements on up to 12 wafers

Communication / integration

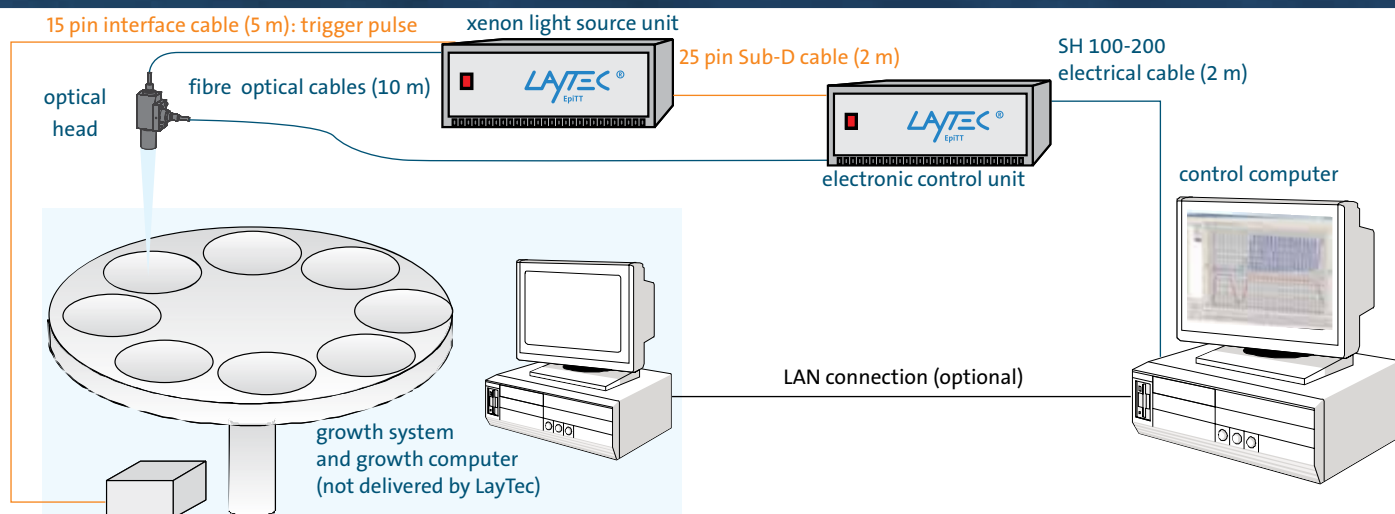
- communication and data exchange with growth system control computer via hardware and open TCP/IP based protocol (suitable for CACE 3.5 and newer, AIXact and custom solutions)
- remote controllable from growth recipe

Measurable growth parameters

- ternary composition: typical accuracy $\pm 1\%$ for AlGaAs
- surface morphology (e.g. nucleation process in GaN growth)
- VCSEL tuning by determining the spectral position of stop band and cavity dip
- reflectance: typical noise better than $\pm 1\%$
- growth rate: typical accuracy better than $\pm 1\%$ (down to 0.001 nm/s)
- wafer temperature (only with TT module): typical accuracy better than $\pm 1\text{ K}$: temperature range: 450 – 1300°C for AIXTRON systems (others on request)



EpiR DA UV (TT) standard package



Optical head

| | |
|---------------------------------------|--|
| light source: | high pressure XBO lamp, 75 W |
| - manufacturer guaranteed lifetime | 400 h |
| - typical life-time | 700 h |
| - warm-up time | 45 min |
| spectroscopic range of detector array | wavelength: 300 nm ... 770 nm* |
| spectroscopic resolution | ± 5 nm |
| integration time | 50...1000 ms |
| number of pixels | 1024 |
| pyrometry wavelength and bandwidth | 980 nm ± 12.5 nm (only with TT module) |
| typical time resolution | 100–300 ms/spectrum incl. data transfer (depends on integration time) |
| data repetition rate: | |
| - in single wafer reactor | up to 1 data set every 4 revolutions of the wafer |
| - in multiple wafer reactor | up to 1 data set every 4 revolutions of the susceptor** |
| typical noise level | < 1% |

Electronic control unit (incl. diode array detector)

The control unit is a standard 19" case that can be easily mounted into existing 19" racks. It is connected with the optical head, the control computer, the xenon light source unit and the growth system as shown in the drawing above.

Xenon light source unit

The xenon lamp is incorporated in the second standard 19" case connected with the optical head (for incoming light) and the electronic control unit as shown in the drawing above.

Control computer

- 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)

Miscellaneous items

- reactor specific mounting and adjustment unit
- manual and software CD
- additional USB license dongle for growth rate analysis and growth rate fit on office computer
- Al-Si eutectic wafer for temperature calibration (special coated 2", 3" or 4" wafer)

*for applications with small aperture view ports or windows with limited transparency the short wavelength limit might be shifted to longer wavelength

** each wafer must be visible through the viewport for at least 95 ms (i.e. max. rotation frequency of e.g. 100 rpm in 6x2" configuration)

EpiR DA UV (TT) standard package

Cables

- 2 optical fibres (optical head <-> electronic unit / optical head <-> xenon light source): 10 m, core diameter 600 µm, special UV-transparent material; minimum bending radius 36 cm
- SH 100-200 electrical cable (2 m, electronic unit <-> computer)
- 25 pin Sub-D cable (electronic unit <-> xenon light source): 2 m, parallel port stepper motor cable
- optionally, a KVM extension set (cable or ethernet based extender) is available
- 15 pin interface cable (5 m, electronic unit <-> growth system): transfers the trigger and marker signals and exports analog voltages proportional to the measured temperature and reflectance (see “communication with growth system” below)
- multi-plug and power cables

Communication with growth system

The electronic control unit is connected to the growth system by a 15 pin interface cable (trigger pulse is mandatory). Optional LAN connection to growth control computer is available. **Please note:** for the LAN connection a special software interface on the growth system computer is necessary. The interface should be arranged by the customer with the manufacturer of the growth system.

| Communication features | 15 pin interface cable | LAN connection |
|---|---------------------------------|--------------------------------------|
| rotation synchronous trigger pulse (once per susceptor revolution) from growth system* | 5V TTL, open collector signal | – |
| 2 digital signals to growth system indicating heartbeat and busy/error status | 5V TTL, open collector signal | – |
| start/stop signal from growth system for remote control from the recipe | 5V TTL or open collector signal | via TCP/IP |
| reflectance calibration signal from growth system to indicate substrate reflectance | 5V TTL or open collector signal | via TCP/IP |
| up to 3 marker signals to indicate different growth steps and for data synchronization with the growth recipe | 5V TTL or open collector signal | via TCP/IP |
| process temperature from thermocouple or Eurotherm for advanced logging and calibration purpose | analog voltage (0-10 V) | via TCP/IP |
| pyrometer temperature to growth system for export of measured temperature (uncorrected or corrected) | analog voltage** (0-10 V) | via TCP/IP (all wafers individually) |
| reflectance signal to growth system for export of the measured reflectance | analog voltage** (0-10 V) | via TCP/IP (all wafers individually) |

Sizes and weights of the parts

| Parts | Size X x Y x Z mm | Weight, kg |
|--|-------------------|------------|
| optical head | 50 x 100 x 150 | 0.2 |
| control unit (19" rack 4 HE, 84 TE) | 450 x 300 x 180 | 8.0 |
| 19" rack for XBO lamp and power supply | 450 x 300 x 180 | 8.0 |
| rack mount control computer (4 HE) | 450 x 600 x 180 | 17.0 |
| 19" LCD display | 410 x 20 x 420 | 5.5 |
| mounting and adjustment unit | reactor specific | 0.2 |

* this line is mandatory for multiple wafer systems and strongly recommended for motor driven single-wafer systems

** in multi-wafer systems only averaged data or data from one specified wafer can be transferred

EpiR DA UV (TT) requirements

Requirements to the growth system

- standard normal-incidence optical view port, customized solutions with two optical heads for other angles of incidence on request
- optical access to the sample:
 - AIX Planetary® G3, G4: 6 mm hole in reactor ceiling
 - AIX 200, AIX 200/4: 6 mm hole in liner tube
 - AIXTRON CCS®: standard viewport equipped with quartz window
 - MBE: heated viewport, no shutters in path of light
- purged or heated window highly recommended to avoid window coating
- for multiple wafer systems: rotation synchronous reset or home pulse from rotation axis, one pulse per revolution (5V TTL, open collector or relay contact)
- max. rotation frequency depending on reactor geometry (e.g. ≤ 100 rpm for 6x2", wafer must be visible for at least 95 ms)
- optional for remote control: hardware and LAN connection to MOCVD system PC (to be arranged with growth system manufacturer)
- feed-throughs for two optical fibers (feed-through plate for KF40 is recommended) if optical head is installed in the glove box

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 |

- vibrations of optical head have to be avoided during the measurement
- optical head is fragile, avoid shock-treatment
- warm-up time: 45 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 / 240 V auto detect
- the power supply must be equipped with grounding wire
- power consumption (typical values for 230 V operation):

| Component | current / A | typical power / W | max. power / W |
|-------------------|-------------|-------------------|----------------|
| control computer | 3.5 | 134 | max. 500 |
| monitor | 1.5 | 26 | 40 |
| XBO lamp rack | 0.6 | 138 | 138 |
| control unit rack | 0.4 | 20 | 69 |
| total | | 318 | 747 |

Availability

EpiR DA TT is available with two different spectral ranges for UV (GaN, oxides) and IR (InP, GaAs) applications (see datasheet for EpiR DA IR TT). EpiR DA UV TT can be adapted to virtually any growth system. We have special mounts for AIXTRON single wafer and Planetary® systems (AIX 200, AIX 200/4, AIX 2400 G3, AIX 2600 G3, AIX 2800 G4 except 24x2" and other multi-wafer per satellite configurations without a wafer in the center), AIXTRON Close Coupled Showerhead® (CCS) reactors (3x2", 6x2", 19x2", CRIUS), for many MBE systems by Riber, Veeco / Applied Epi, VG and various custom built systems.

Specifications are subject to further technical development and may differ from those given in the datasheet.

Version 5, March 2011



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