AlignR – LayTec's solution for assisted alignment of wafer bow-resistant measurement heads

The strive for ever-larger wafers in metal-organic chemical vapor deposition (MOCVD) also requires ever-larger tolerances of optical in-situ metrology systems against wafer bow as they have been realized in LayTec's latest EpiCurve® TT metrology systems. In order to fully exploit the advantages of this increased tilting tolerance the measurement head needs to be aligned on a precision level which can hardly be achieved manually. Therefore, LayTec introduces its novel automated alignment tool "AlignR" to enable customers to easily find the optimum alignment configuration.

As the tendency of the MOCVD industry towards the deployment of ever-larger wafers continues and even intensifies, the curvatures of wafers result in ever-larger absolute wafer bows and consequently also larger deflection of incident beams. This requires that in-situ metrology systems also become evermore tolerant against the deflection of the reflectance signals. This can be achieved by designing the optical setup to exhibit a broad intensity plateau (see **Fig. 1a)** and **b)**) with respect to the relative positioning of the measurement head and the wafer at the position of incidence. However, to fully exploit the advantage of such a plateau, the user needs to align the measurement head in a way that it is positioned in the center of this plateau. In systems with less sophisticated optical designs (see dashed line in **Fig. 1a)**) the alignment is rather straight forward, as the user merely had to align for maximum intensity. For a broad plateau (see solid line in **Fig. 1a)**) a change in position will not lead to a detectable change in intensity until a sharp "edge" is reached at which intensity rapidly decreases as it can be seen in the intensity curves in **Fig. 1b)** detected on an EpiCurve® TT during alignment. Therefore, a manual alignment in three dimensions becomes practically impossible. The automatic alignment tool AlignR was created to solve this issue. The tool is shown in **Fig. 1c)** in operation on an EpiTT head. It consists of a hardware device connected to its dedicated software on a service laptop to which it connects wirelessly. The laptop then directly connects to the controller of the in-situ metrology system to obtain the respective reflectance signal*. The AlignR directly drives the respective alignment screens according to a dedicated sequence (see **Fig. 1a)**) to determine the optimum alignment position in an automated way to find a consistent high value and to speed up the process in a reproducible way. This is achieved by turning each screw (step 1) in both directions, finding the width of the resulting data at half of the maximum reflectance value (full width half maximum (FWHM); steps 2 & 3), and finally setting the screw to the center of that position (4). In the following section, the general procedure is explained in greater detail:

*) Note that for older EpiCurve® TT versions, **AlignR** requires an additional portable control unit for connecting to the controller.

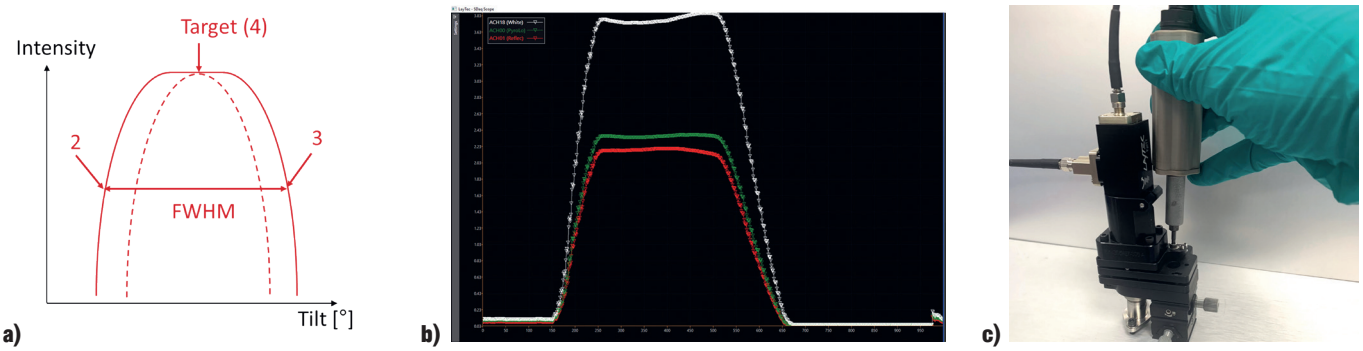

Fig. 1 a) Schematic of the procedure for determining the position of optimum intensity for broad intensity plateaus: Firstly, AlignR drives each screw into both directions until both full width half maximum positions are determined (2, 3) which are used to deduce the center point as a target; **b)** examplary intensity plateaus obtained on an EpiCurve® TT; **c)** AlignR applied to an EpiTT head.

General Sequence of Alignment Process:

- Identify the measurement head to be aligned and allocate the alignment screws.
- Ensure that any screws that need to be aligned have associated locking screws or stoppers loosened.
- Plug in motor controller box of the **AlignR** tool to desired power source (AbsoluT battery is recommended).
- Turn on wireless protocol (e.g. Bluetooth) on service PC; alternatively connect **AlignR** to PC using micro USB port.
- Open **AlignR** program on service PC.
- Verify that correct device is selected.
- Verify that (for a multi-head system) selected reflectance signal matches the head to be aligned by **AlignR**.
    - If this step is skipped, motor will detect that there is no change in reflectance and reset to initial position.
- Press connect button and verify that reflectance channel shows non-zero data.
- Ensure speed and the percent of start for alignment borders are set to desired values (default values are provided but can be overwritten, if user seeks a faster alignment or an even more precise usage on very sensitive screws).
- Press “Start Alignment” when **AlignR** tool is connected to desired screw and wait until the process is complete as shown on the program.
    - This will initiate the actual physical alignment process, during which **AlignR** will drive each screw into both directions until the two FWHM are determined from the reflectance intensity maximum and minimum reading for one driving direction after the other.
    - Thereby, the **AlignR** software will save the mechanical positions corresponding to the two FWHM and calculate the center position.
    - Finally, it will drive the screw to the center position which will allow for a maximum in tilt-tolerance in the actual processes.
- Repeat alignment on each screw as desired, going back to initial screws if further adjustments have any effect on the reflectance

The generality of this procedure applied by **AlignR** will guarantee to find the optimum alignment position in very short times in an automated way. It also needs to be noted that the automated procedure will also remove any personal operator influence from the alignment process and will thereby increase the reproducibility. Furthermore, it will also enable advanced end customers to fulfil alignment task that previously demanded for external support which may also help to reduce system downtimes after maintenance.

In order to make the use of **AlignR** as convenient as possible, the following features have been implemented:

Key Features:

- Automated positioning in the center of intensity plateau.
- USB connection / no cables at the reactor during alignment.
- Portability due to very light design.
- **AlignR** can be transferred between systems without any permanent or semi-permanent installations
- Ability for use within glove box due to wireless connection between **AlignR** electronics and the device that instructs the screwdriver motor controller.
- Flexibility in application:
    - Whilst designed for aligning the measurement head, any device that has a screw that affects measured reflectance values can theoretically use **AlignR** for optimizing the signal.
- Adjustable speed.
- Alignment process: consistent method for keeping reflectance values and tilt tolerance high.
- Use of stepper motor to get increased accuracy
- Adjustability for definition of endpoint at either side of screw.
- Program outputs alignment data to give visual feedback on the alignment process
- Freedom to choose any wavelength (or channel) for alignment process.
- Applicable to multi-head system by sequential optimization.
- Virtually, independent of particular reactor or mounting geometry due to slim design and manual positioning.
- Can be powered by AbsoluT battery, thereby supporting lean spare part management.

Interested in an AlignR demo?
Please contact LayTec service via info@laytec.de.