Use of LayTec EpiTT in a Mass Production Environment

LayTec's online in-situ seminar 2025

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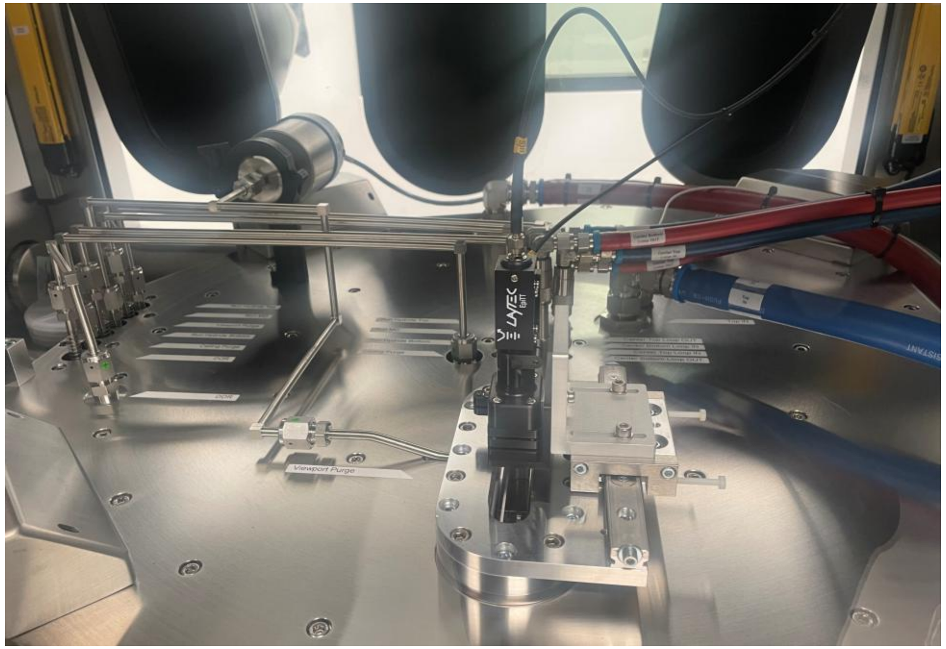
IQE

Introduction

- Brief introduction to IQE
- LayTec EpiTT usage (for GaAs and InP products) in:
  - Maintenance
  - Calibration
  - Production
- Estimating the GRR of the LayTec for thickness



Aixtron G4 planetary reactor. IQE has 13 installed at its South Wales sites all with LayTec EpiTT systems

Strategically positioned in the global value chain

Growth Markets

Smart connected devices

Communications infrastructure

Automotive and Industrial

Unique global footprint

Europe

Cardiff
Innovation Centre

Newport
Manufacturing platform: MOCVD

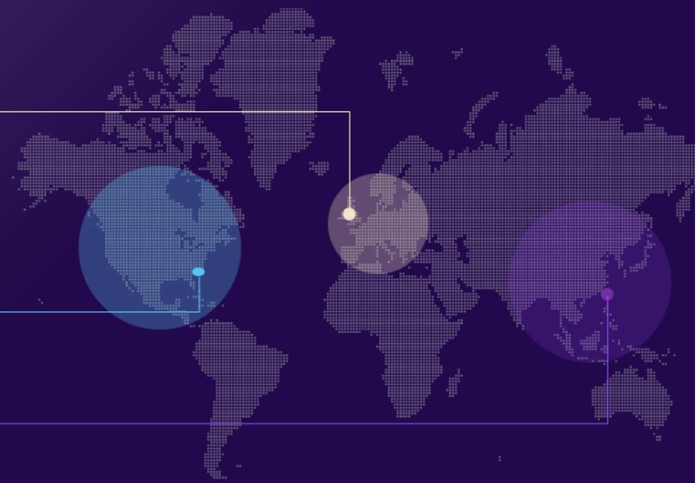
North America

Massachusetts
Manufacturing platform: MOCVD

North Carolina
Manufacturing platform: MBE

Asia

Taiwan
Manufacturing platform: MOCVD, MBE



Industry Leading Technology Portfolio

Scaled material platforms

GaAs	GaN	InP	GaSb
Gallium Arsenide	Gallium Nitride	Indium Phosphide	Gallium Antimonide

Connect

Sense

Display

Power

Scale across all epitaxy manufacturing technologies: MOCVD, MBE, CVD

30+ years of trade secrets and patents covering all technology development areas

GenAI ready portfolio

Edge AI	Connect anywhere	Cloud
VCSELs, lasers, detectors	GaN RF, GaAs HBT	Quantum lasers, Photonics InP, VCSELs

InP: Accurate & advanced sensing

InP: Ultra-low latency, high bandwidth connectivity

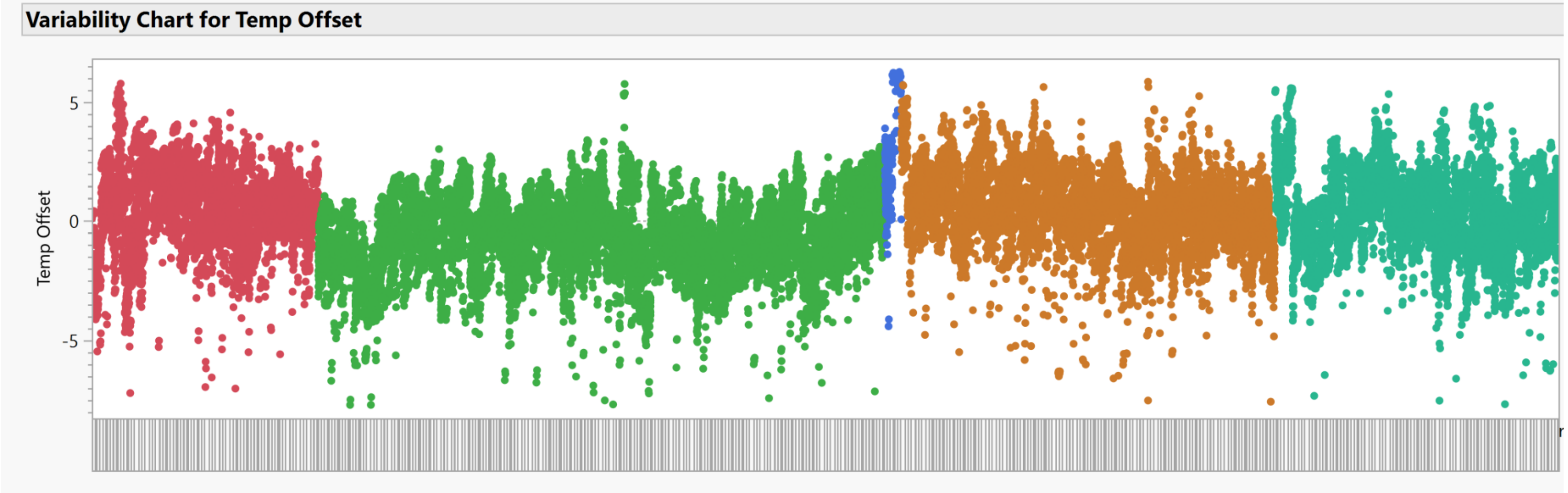
GaN: Efficient power and microLED displays

LayTec Usage in Mass Production – Maintenance

- Use of LayTec Absolut black body calibration device gives good build to build and reactor to reactor repeatability
- LayTec TrueTemp used as part of the acceptance criteria in IQE's green-to-green handover from tool maintenance to production
- Used to verify (and if needed correct) a reactors temperature for given inputs

LayTec Absolut used to calibrate an EpiTT system during a maintenance activity
Image credit: LayTec

Data for circa 7,200 wafers showing the LayTec temp offset. Reactor temps are matched using all temperature sensitive characterisation giving matched product performance



LayTec Usage in Mass Production – Calibration

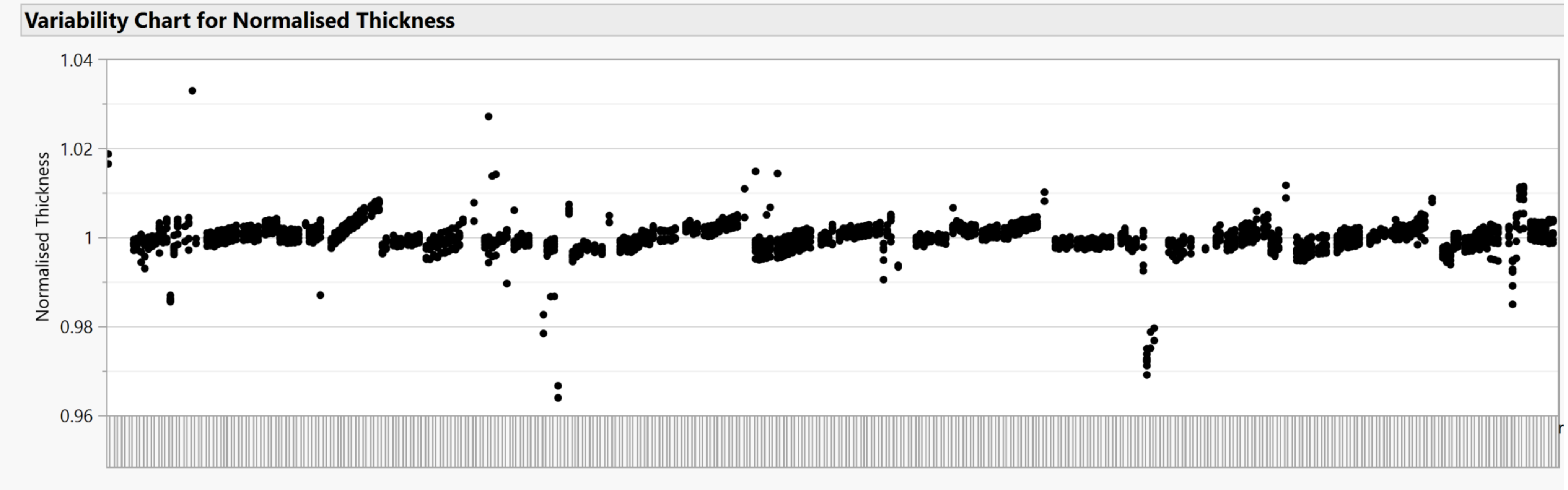
- Reactor temperatures verified by LayTec TrueTemp on each calibration
- LayTec primary means of measuring growth rate
- LayTec primary means of measuring Al_xGaAs composition for x > 35%

LayTec Advantages
- Accurate & repeatable data, available as soon as run has finished
- Removes additional characterisation steps e.g. SEM for thickness or XRD for composition
- Allows thinner structures (SEM requires greater thickness for good GRR)

LayTec Disadvantages
- Initial usage for some customers problematic due to qualification
  - ISM top plate (G3 reactors)
  - Change to calibration methodology
- If the LayTec doesn't record then runs must be repeated

LayTec Usage in Mass Production – Product

- LayTec TrueTemp on SPC charts – catches drifts or issues
- If a layer is >200nm thick, with a constant composition and sufficient refractive index contrast we will be tracking its thickness using the LayTec EpiTT
  - Laser claddings and contact layers
  - VCSEL bulk layers
  - *pin* absorber or contact layers



Thickness data for ~2500 wafers

Gage Repeatability and Reproducibility

Measurement systems analysis looking at measurement variation from equipment and operators:

- At IQE typically run as 2 samples x 2 operators x 5 measurements
- Outputs show contributions due to operator/appraiser variability and equipment variability
- Overall number expressed as process to tolerance ratio
- Customers ask for this: do we have good enough measurements to adequately control our/their products

GRR P/T Value	
<10%	Acceptable
10-30%	May be acceptable May require guard bands, improvement plans
>30%	Unacceptable, requires improvement

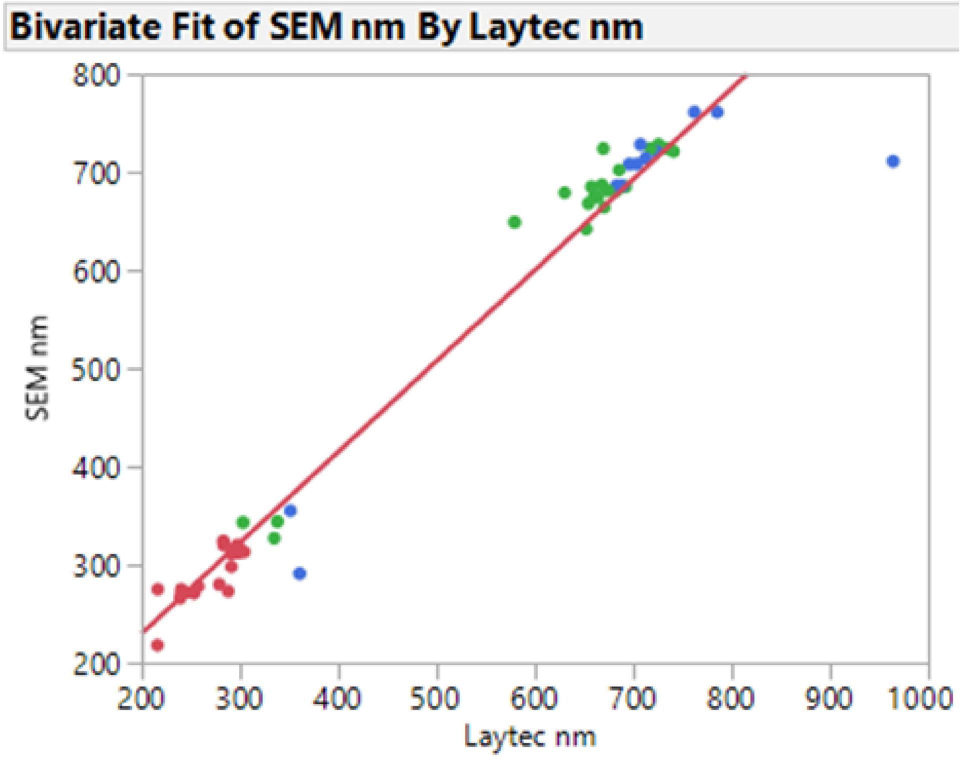
LayTec is not a measurement that can be repeated or measured by different operators making it difficult to measure conventionally

Approximating LayTec EpiTT GRR

- Infer GRR by comparison of SEM (known GRR) to LayTec
- Calculate standard deviation of deviation from fit for for LayTec and SEM:

	SEM	LayTec
Mean of deviation	20.6 nm	15.0 nm
Std Dev of deviation	39.3 nm	16.2 nm

- SEM GRR P/T 9.4% for layers 700-900nm and +/- 2% tolerance
- Taking ratio of std deviations enables an estimation of LayTec EpiTT P/T = 16.2/39.3 x 9.4 **= 3.9 % for +/-2%**
- LayTec enables this P/T to be achieved with much thinner layers too, validated by fitting growth rates to partial layer thicknesses



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