APPLICATION NOTE

EpiTT goes GaN MBE !

LayTec's in-situ optical sensor EpiTT, measuring real-time growth rate and true wafer temperature, has become a standard tool for GaN MOCVD. Now we are proud to report a very successful application of EpiTT in GaN MBE. Using it on a Riber Compact 21 MBE system, Dr. Yvon Cordier at CRHEA (Valbonne, France) has recently demonstrated that EpiTT can determine wafer temperature to ±1 K and layer thickness to ±0.1% of total thickness during MBE on Sapphire.

Sensitivity of EpiTT equipped with a new optical set up designed for MBE environment has been evaluated at CRHEA. Results obtained by Dr. Cordier showed that EpiTT can now be utilized in commercial MBE systems for in-situ measurements of wafer temperature and growth rate with excellent accuracy and sensitivity.

Utilizing Emissivity Corrected Pyrometry (ECP) capability of EpiTT, wafer temperature was determined with an accuracy better than 1 K for all types of substrates used! Effects of stray light from the MBE sources were almost completely suppressed by a new optical set-up. True Temperature and 633nm/950nm reflectance measurement for GaN/AlN on Sapphire are shown in Fig. 2.

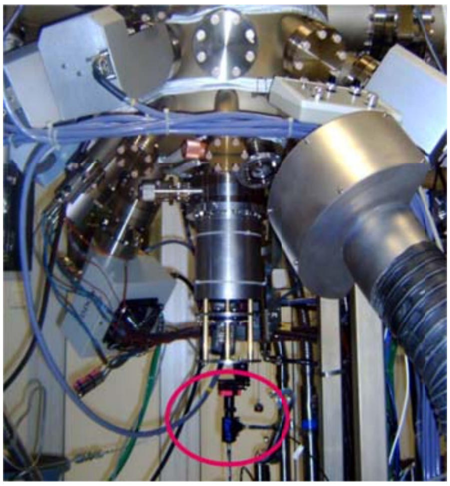

Fig. 1: EpiTT installed on a Riber 21 Compact at CHREA (France)

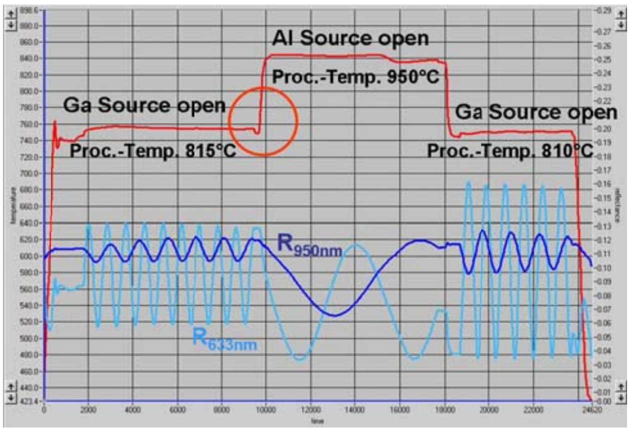

Fig. 2: Wafer temperature and 633nm /950nm reflectance as measured during a HEMT growth run.

The 950nm reflectance signal has been used for automated emissivity correction. Hence, there are no remaining Fabry-Perot-oscillations in the wafer temperature.

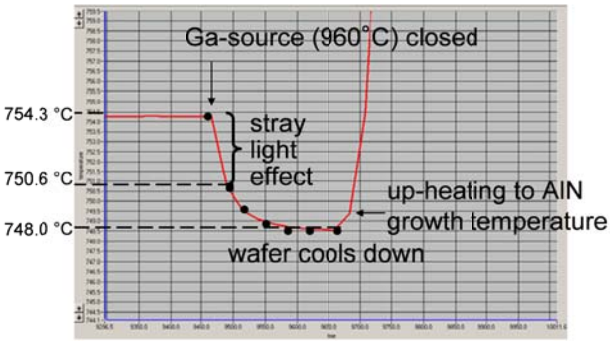

Fig. 3: Enhancement of the red circle in Figure 2: small remaining tempera-ture offset (<4K) due to the hot Ga source.

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Moreover, as can be seen in the plot of the 1st switching sequence (Fig. 3), when the Ga source shutter is closed, wafer temperature drops by 3.7K. This effect is attributable to stray light artifacts (IR-radiation from the Ga source) superimposed by a real down-cooling effect of the wafer when there is no heat from the Ga-source. With the new design of the fiber-optical head the stray-light contribution was tremendously reduced. The real effect of the Ga-Source on the wafer temperature is in the range of 2K.

Previous band edge measurements of hetero-structures on Silicon had failed, despite good results for GaN growth on templates. The fundamental reason is that temperature measurements through band edge in the case of hetero-structures suffer from strain-induced band edge shifts and distortion of the signal by Fabry-Perot interferences.

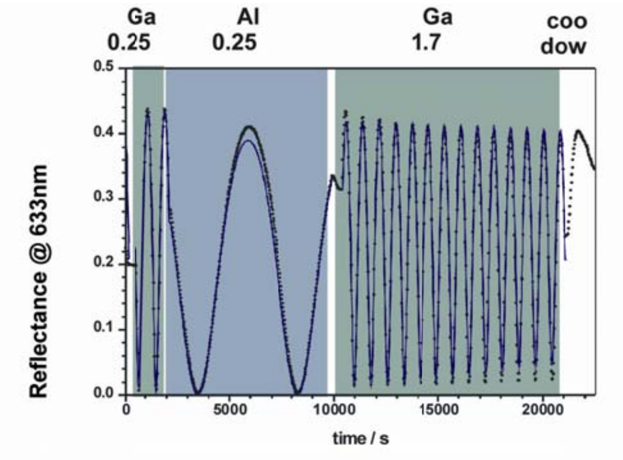

Fig. 4: In situ 633nm reflectance measurements of GaN/AlN/GaN growth on Silicon in a Riber Compact 21 performed by LayTec's **EpiTT** sensor. Black curve – as measured; blue curve – fitted by multi-layer simulation software.

Growth rates determined from reflectance measurements:	
GaN: 0.25 µm	0.1602 ± 0.0006 nm/s
AlN 0.25 µm	0.0310 ± 0.0002 nm/s
GaN 1.7 µm	0.1665 ± 0.0002 nm/s

The accuracy of the reflectance based in- situ film thickness measurement is excellent.

Fig. 4 gives as an example the fitted growth rates of the GaN/AlN/GaN hetero-structure. This accuracy has been achieved due to the excellent signal-to-noise ratio of the reflectance measurement and by using LayTec high-temperature n & k data base for AlGaN. The in-situ measured wafer temperature is used for automatic selection of the appropriate n and k values for the respective material and growth step.

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