APPLICATION NOTE

HVPE growth of bulk GaN controlled by EpiTT 3λ

Hydride Vapour Phase Epitaxy (HVPE) is an epitaxial method for production of compound semiconductor materials that offers a high growth rate and a controlled geometrical size. It is well known that tight growth monitoring is indispensable during the HVPE growth. In the first tests conducted at Ferdinand-Braun-Institut (Berlin, Germany) on an AIXTRON / Epigress vertical HVPE system, LayTec's in-situ sensor EpiTT proved to be a powerful tool for a precise growth control of bulk GaN substrates.

For HVPE application an **EpiTT** providing growth monitoring at three wavelengths was developed, featuring: reflectance at 400 nm for the most sensitive surface roughness control, reflectance at 633 nm for growth rate determination during the growth of the first 10 µm and reflectance and pyrometry at 950 nm, where reflectance has the potential of growth rate measurements for very high growth rates.

Besides, pyrometry measurements at 950nm give the temperature of the wafer carrier simultaneously. These temperature measurements showed that the substrate temperature during heating was more than 100°C higher than that measured by the thermo-couple from the back side of the heating system. This result already proves the advantages of pyrometry measurements, which helped optimize the heating ramp and growth conditions in this case tremendously.

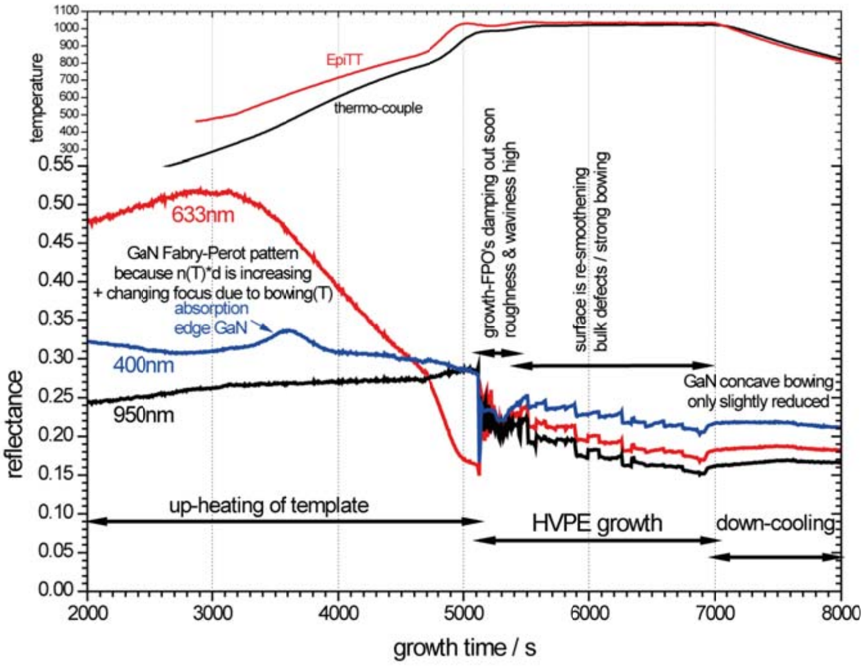

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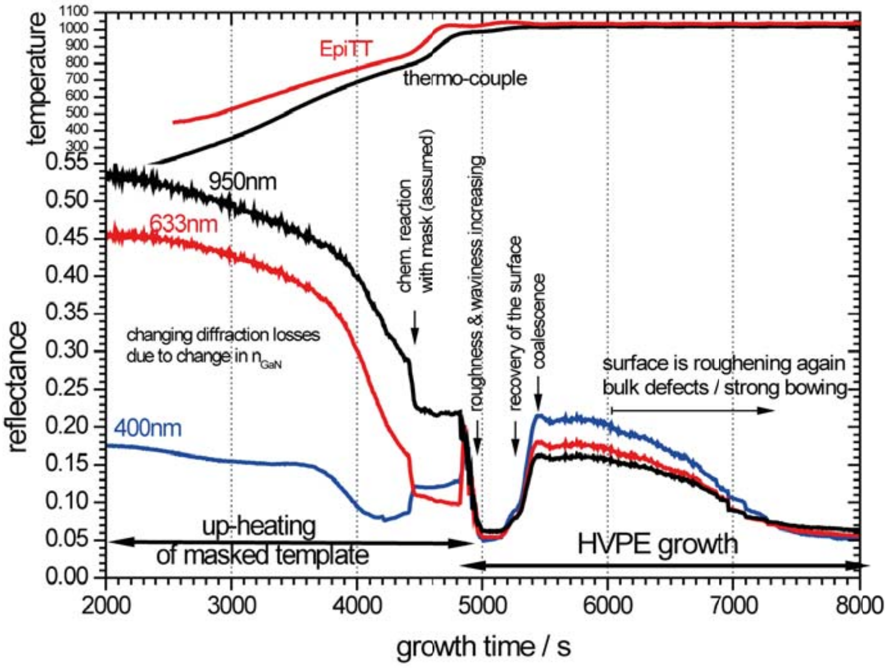
Fig. 1 shows the reflectance and pyrometry data as measured during growth of a 127µm thick GaN layer at 1020°C on a GaN/sapphire template. All reflectance data was normalized to the nominal values at the beginning of the growth. The reflectance traces were used for evaluating and improving the HVPE process. As the result of the improvements, a very thick GaN film with a mirror like surface was achieved.

When the substrate is heated, a Fabry-Perot response is clearly visible in the reflectance data at 633nm. Since the optical thickness (n*d) increases due to the increase of the refractive index of GaN at higher temperatures, the reflectance signal shows a modulation with temperature. The 400nm reflectance signal gives a signature at ~500°C when the thermal band gap shift makes the GaN template opaque for this wavelength. Additionally, reflectance intensities are superimposed by intensity changes due to wafer bowing.

When the HVPE growth starts (after 5100s), the 400nm reflectance decreases due to surface roughening and both the 633nm and 950nm reflectance move towards their average values because of the increasing substrate waviness. After 200s of growth the surface starts to recover and the 400nm reflectance improves. However, due to crack and defect formation the increase of the 400nm reflectance signal is regularly interrupted by intensity losses. Measurements at 633nm and 950nm are less sensitive to roughness and only affected by the overall reduction of the measured reflectance due to stray light losses. When the growth is stopped, the reflectance at all three wavelengths increases by about two percent. This might be attributed to the temperature change.



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