5 × 3 inch group-III nitride growth in production scale MOVPE systems

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The rapid growth of the optoelectronic market segment occupied by group-III nitrides has strengthened the demand for higher production capabilities. Besides the increase in the number of wafers grown in one epitaxial run larger wafer sizes are a natural consequence.

We report on wavelength and thickness homogeneities achieved in AlGaN/GaN and InGaN/GaN multi quantum well (MQW) and electroluminescence test (ELT) structures in an AIX 2400 G3 system in the 5 × 3" configuration. TMGa, TEGa, TMIn, TMAl, NH_3, SiH_4 and Cp_2Mg were used as precursors at reactor total pressures of 200 mbar under H_2, N_2 and a mixture of both. Typical growth temperatures were between 750°C and 1150°C depending on the material composition of the growing layer. Extensive modeling of the reactor and all its components was used to optimize the reactor design. The transfer from the 6 × 2" to the 5 × 3" configuration was made by simple scaling of the process parameters on the basis of the modeling results. The wafers were characterized by room temperature photoluminescence (RTPL) mapping, thickness mapping and electroluminescence measurements. In addition, in-situ reflectometry was used to monitor the growth process (see fig. 1). Thus, the same layer properties could be assured by matching reflectometry curves obtained on 3" to those of comparable 2" wafers.

RTPL measurement exhibited excellent wavelength homogeneities of about 1% at 480 nm without rim exclusion (see figs. 2,3). In addition, several consecutive nominally identical runs exhibited an excellent run-to-run reproducibility of less than 1% standard deviation of the wavelength. Experiments on n-type GaN:Si layers exhibited doping uniformities of around 5% standard deviation on 3".

With these prospects ELT structures were grown and processed. Emission wavelengths of 480 nm were achieved. The typical forward voltage was 4 V at 20 mA indicating sufficiently high doping levels for industrial production. Sheet resistivity mappings of these structures exhibited standard deviations below 1.8% without rim exclusion.

Additional data as well as the usage of in-situ reflectometry in the scaling of MOVPE processes on AIXTRON systems will be discussed. Results on AlGaN/GaN MQW and ELT structures will be presented.

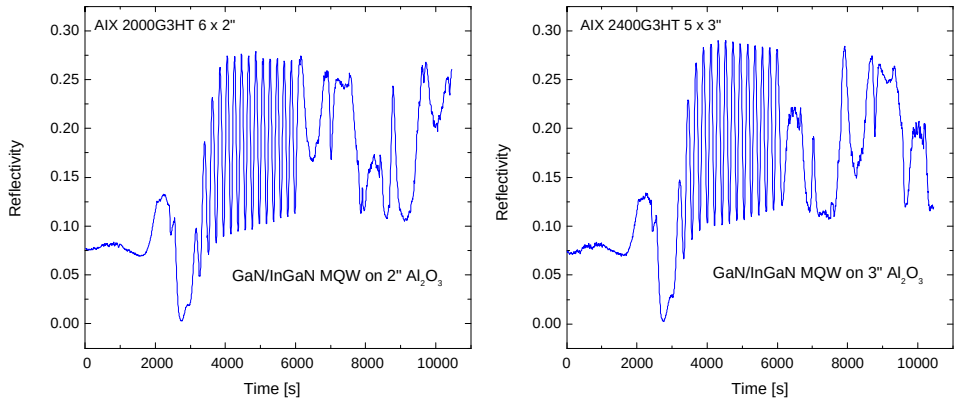

Fig. 1: Comparison of reflectance spectra of 5 period InGaN/GaN MQW structures grown in 6×2" and 5×3" planetary reactor configuration, respectively.

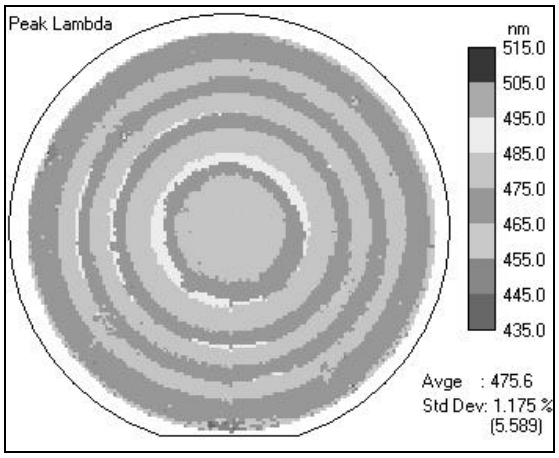

Fig. 2: RTPL mapping of a 5 period InGaN/GaN quantum well structure grown on 3" sapphire. Standard deviation of wavelength using 3 mm rim exclusion is 5.6 nm which is 1.2%.

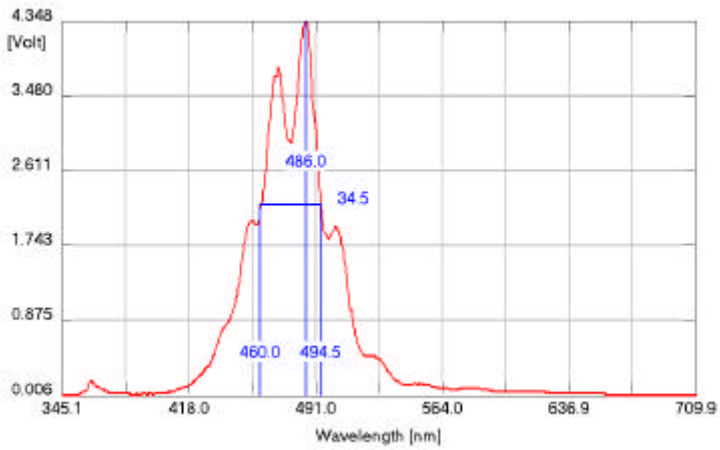

Fig. 3: Typical photoluminescence spectrum of a 5 period InGaN/GaN MQW structure. Wavelength is 480 nm, full width of half maximum (FWHM) is about 35 nm.