APPLICATION NOTE

STATE OF THE ART QUALITY OF GaN & AlGaN QUANTUM WELL GROWN ON GaN TEMPLATE

Introduction

GaN material is desirable for electronic applications due to its physical properties, its performance capabilities in the field of high power, high frequency transistor covering the 1-50 GHz band. This band includes wireless networking, radar applications and microwave communications. Key feature GaN compound remains in the choice of an optimal substrate between silicon carbide, silicon, sapphire, GaN template, considering cost, performance and reliability.
In this application note, Riber's GaN Process Technology Center (PTC) reports the growth and optical quality of thick GaN and AlGaN/GaN single quantum well (SQW) heterostructure grown on 50 mm (2") MOCVD grown GaN on sapphire template.

Crystalline properties were investigated by low temperature photoluminescence (PL) technique performed with a 10mW HeCd laser.

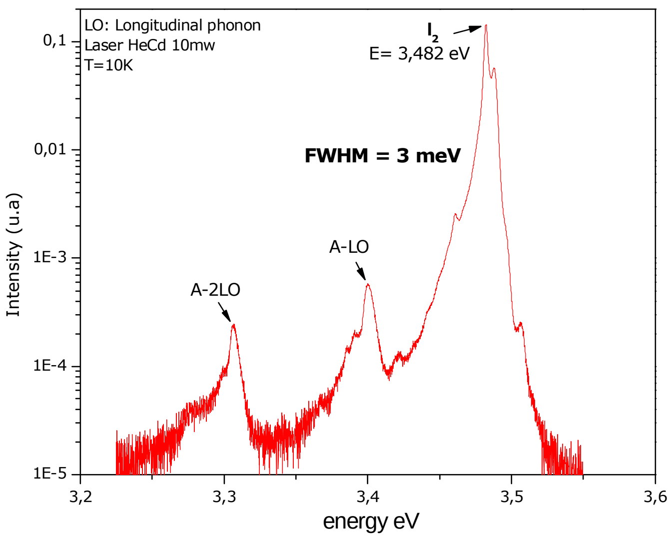


Figure 1: **10 K Photoluminescence (PL) spectrum for high purity GaN (2µm) grown on a GaN template**

Results

Crystalline quality of GaN

A 2µm thick GaN layer was grown at 800°C under 200 sccm NH_3 flow rate with a growth rate of 1µm/h on a GaN template.

The PL spectrum shows (figure 1) the high quality of the sample. The PL spectrum is dominated by the neutral donor bound exciton line I_2 at E=3.482 eV and by two phonon replicas . The I_2 recombination peak exhibits a Full Width at Half of 3 meV.

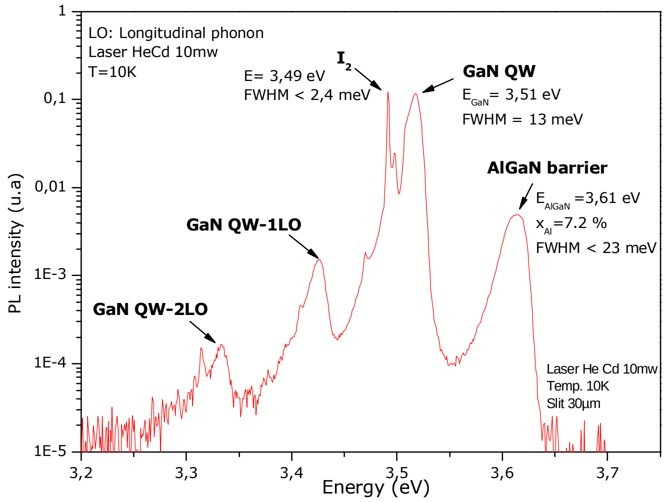
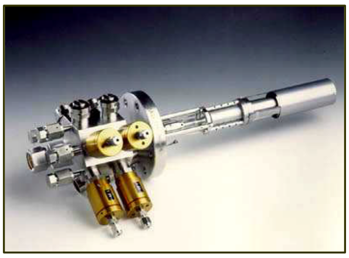


figure 2: **10 K Photoluminescence (PL) spectrum AlGaN/GaN SQW grown on a GaN template**



Ammonia delivery module

Group III Effusion cells

Optical quality of quantum structure

The AlGaN/GaN quantum well grown on GaN template consists of 1 µm thick GaN buffer layer followed by 200 nm AlN barrier. A 26 Angstrom GaN quantum well is then grown and capped with a 50 nm AlGaN barrier. The quantum well, barrier and buffer layers were grown at 800°C under 200 sccm NH_3 flow rate and at a growth rate close to 1 µm/h.

The PL spectrum is reported in figure 2. The AlGaN peak appears at 3.61 eV corresponding to the targeted Al composition of x=7.2%, the FWHM of the PL peak (less than 23 meV) attests the quality of the AlGaN material. The PL spectrum is dominated by two peaks, the neutral donor bound exciton I_2 of the GaN buffer at 3.49 eV and the confined state in the GaN quantum well at 3.51 eV followed by two phonons replicas. The FWHM of the I_2 peak of the GaN buffer is better than 2.4 meV. On the other hand, the FWHM of the quantum well PL peak is 13 meV due to the vicinity of the B free exciton luminescence. After deconvolution, the FWHM of the GaN quantum well decreases to less than 10 meV.

Conclusion

Successful bulk GaN and AlGaN/GaN SQW growths in the Compact 21T–GaN research system have been demonstrated. PL spectra shows the outstanding crystalline quality of the structure resulting of the extreme purity of the system. The excellent growth parameter optimisation, material fluxes, composition, temperature, thickness uniformities lead to state-of-the art results.

Experimental

Growths were carried out in the Compact 21 T GaN research system equipped with a high temperature oven, ABN 80 cc effusion cells for group III elements and as a nitrogen source an ammonia delivery module HTI 63.

About GaN PTC

GaN PTC at CRHEA Valbonne, allows customers and prospective users to test the Compact 21T GaN for growth of structures or target specific device properties to enhance and accelerate their process knowledge. Training courses may be tailored to meet individual requirements. Experience accumulated in advance of system delivery saves months of post-installation process development.

For more information please contact info@riber.com