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APPLICATION NOTE

Preliminary characterizations of III-N layers by PA-MBE in Compact 21

Introduction

The work reported in this application note has been achieved at RIBER Process Technology Center (PTC GaN) at Valbonne, France, in collaboration with the CRHEA-CNRS in the Compact 21, especially designed for high quality nitride structures.

Given PTC GaN and CRHEA knowledge in nitride growth using ammonia source, work has been carried forward to starting the N_2 RF plasma source from ADDON. Preliminary studies consisted in the determination of the crystalline quality and surface roughness of 1 to 2µm GaN films grown on GaN on sapphire templates with target to show that al results are consistent with the state of the art of GaN –N plasma and comparable to results obtained with an ammonia source.

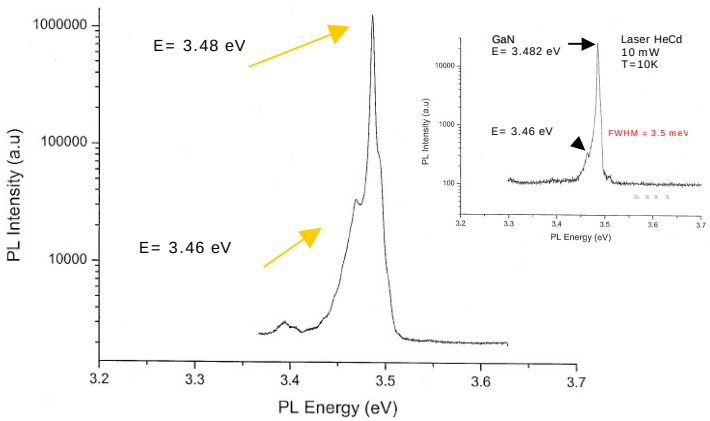

Figure 1: 10 K photoluminescence (PL) spectrum for thick 2µm GaN on GaN template grown by PA-MBE and grown by Ammonia MBE in the insight

Results

Excellent crystalline quality

Samples were characterized by low temperature photoluminescence performed with 10mW HeCd laser. Figure 1 displays the photoluminescence spectrum recorded at 10K. The intense band edge is dominated by a sharp emission peak (FWHM = 3,3meV) located at 3.48 eV, corresponding to the neutral donor bound exciton D°X. The shoulder on the left side of the band at 3.46 eV corresponds to the 2 electron replica of the exciton line D°X.

Results are consistent with the state of the art of N plasma growth and the ones previously obtained using NH_3 ammonia source as a precursor (see insight). Photoluminescence spectrum outlines the excellent crystallinity of the sample, necessary to achieve high performance devices

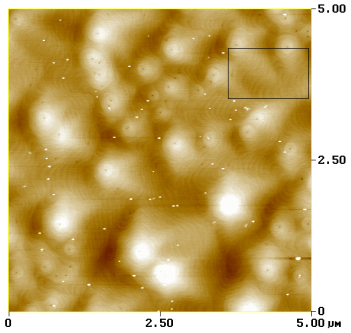

Figure 2 : 5x5 µm² AFM image of thick GaN on GaN on sapphire template by PA-MBE

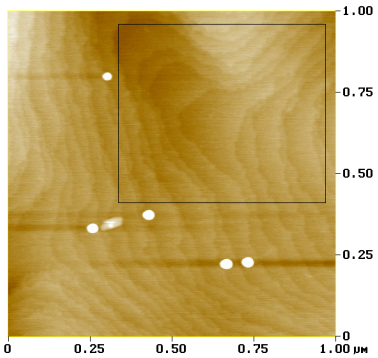

Figure 3 : 1x1 µm² AFM image of thick GaN on GaN on sapphire template by PA-MBE

Surface roughness at the state of the art

Atomic force microscopy is used for surface characterization of a 1.4µm GaN layer. The surface roughness is deduced from root mean square (rms) roughness value of the AFM scans presented in figure 2 and 3.

The 5x5 µm² scan shows atomic steps visible on surface with roughness at 0.54 nm. The small white spots are residues of Gallium droplets due to the growth at the limit of Ga stabilized regime. A closer look to the 1x1µm² scan, figure 3, allows to observe the atomic steps with roughness at 0.276 rms, value at the state of the art.

Conclusion

We have grown III-V nitride structures in our Compact 21 T MBE research system. Structural and optical studies all demonstrated state of the art results, making our growth process and dedicated equipment the best for III-N technology.

System configuration

All epitaxial structures were carried out in the Compact 21 T GaN MBE research system equipped with RIBER ABN 80 cc effusion cells for group III elements and as nitrogen source a radio frequency plasma source from ADDON.

About PTC

PTC allows customers and prospective users to test growth 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.