

APPLICATION NOTE

OUTSTANDING RUN TO RUN REPRODUCIBILITY OF THE MBE 49

Introduction

The work reported in this application note was carried out in collaboration with Alcatel-Thales III-V Lab at RIBER As/P Process Technology Center (PTC) located at the IEMN, Lille. Thales scientists worked on AlGaAs/GaAs QWIP, to transfer the process from a single to multi-wafer system, and check run to run reproducibility over one week at the PTC on the MBE 49 MBE system.

Thales R&T has designed, grown, processed and produced a wide variety of Quantum Well Infrared Photodetector – QWIP- for many years; single and multi-color, AlGaAs/GaAs and GaInAs/GaAs structures. Main applications include thermal imaging for both military and commercial applications. QWIP are one of the most stringent structures to realize.

III-V Lab is very demanding concerning the features a production system has to fulfil in order to grow such devices. Thickness and composition tolerances are very tight: $\pm 0.5\text{\AA}$ for the GaAs quantum well thickness and $\pm 0.2\%$ in Al mole fraction of the AlGaAs barriers. Uniformity requirements on 3" are also very rigorous, particularly for the fabrication of Focal Plane Arrays (FPA). In addition, the system must allow excellent run to run reproducibility.

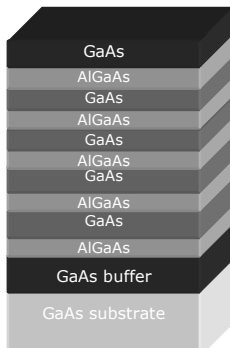


Figure 1 : QWIP Structure

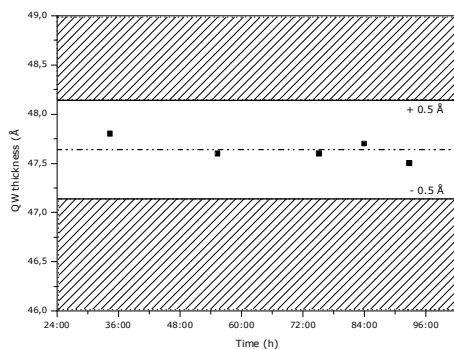


Figure 2: GaAs quantum well thickness variation over 96 hours

Experimental

Epi-structure consisted of GaAs wells embedded between AlGaAs barriers. Growths were performed on 3" SI GaAs substrates. Effusion cells used for Ga and Al materials were left at growth temperature all the time i.e 96 hours. This time corresponds to the growth of a batch of 12 platens (5x3") of QWIP structures.

Results

Outstanding run to run reproducibility

- Run to run GaAs thickness variation $< \pm 0.5\text{\AA}$.

Figure 2 shows, from X-ray measurements, the run to run evolution of the GaAs quantum well thickness, during 96 hours. Total deviation of the quantum well thickness is only $\pm 0.15\text{\AA}$ widely underneath specifications.

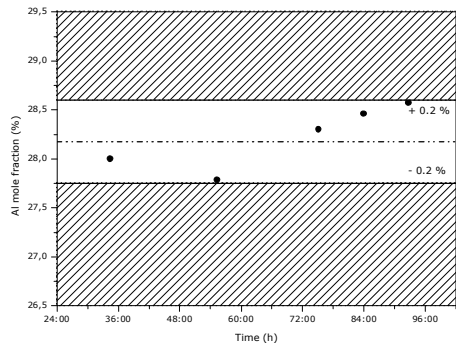


Figure 3 : Al mole fraction variation over 96 hours

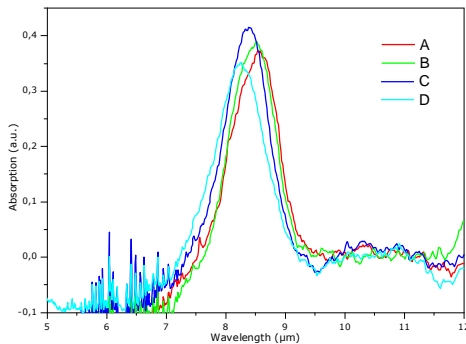
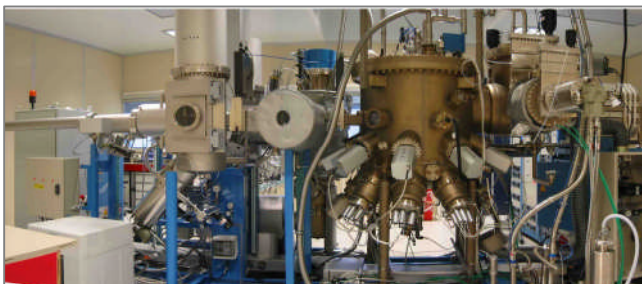


Figure 4: Quantum well absorption measurements



MBE 49 Production system

- Run to run Al composition variation $\pm 0.2\%$.

Figure 3 represents the Al mole fraction variation of the AlGaAs barriers from run to run over 96 hours (5 substrates measurement over the 12). Results shows an Al deviation of $\pm 0.2\%$ satisfying demanded specifications.

- Run to run wavelength variation.

Figure 4 absorption measurements on four substrates (A,B,C,D), chosen among the 96 hours campaign, highlights a wavelength variation of only $\pm 0.17\mu\text{m}$, resulting of a perfect control of the growth rate.

Conclusion

We have outlined through the growth of such structures the notable run to run reproducibility which are better than the required production specifications. All growth parameters (flux, growth rate, temperature) are perfectly and easily controlled making the MBE 49 and its related equipments the ideal tool for the production of these very demanding QWIP structures.

System configuration

Growths were carried out in the PTC MBE 49 multiwafer production MBE system equipped with ABN 700 cc, and ABI 1000 effusion cells for group III elements and with VAC 2000 and KPC 1200 valved cracker cells for arsenic and phosphorus respectively.

About PTC

The As/P PTC at IEMN- Lille allows customers and prospective users to test structure growths 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

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