Extended Abstracts of the 1999 International Conference on Solid State Devices and Materials, Tokyo, 1999, pp. 206-207 **C-5-1**

Invited

MOCVD Growth of GaN for Blue Lasers and High Electron Mobility Transistors

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INTRODUCTION

Lateral epitaxial overgrowth (LEO) of low defect density GaN by MOCVD is demonstrated and characterized using scanning electron microscopy, atomic force microscopy, transmission electron microscopy, x-ray diffraction, photoluminescence spectroscopy, and cathodoluminescence imaging. As was demonstrated by Nakamura et al[1], devices fabricated on LEO materials shown improved characteristics, in particular we have observed a large reduction in leakage current under reverse bias is observed for p-n junction and UV photodetectors, and AlGaN HEMTS.

RESULTS

In recent work on LEO GaN substrates we have dramtically improved internal efficiency and threshold current for blue laser diodes. For laser diodes fabricated on LEO wing regions we have observed threshold current denisties as low as 4.8kA/cm2 , which is much improved in comparison to 9kA/cm2 on conventional planar GaN/sapphire structures. Addtional, we have used lateral overgrowth over grating structures to achieve blue DFB lasers with single mode emission as shown in Figure 1. For UV detectors fabricated on the "wing" region of the LEO a reverse-bias dark current of 10nA/cm2 is measured, in contrast to 300mA/cm2 for conventional dislocated GaN diodes. LEO diodes also exhibit a decrease in unwanted sub-band gap spectral response and improved signal-to-noise characteristics due to reduced dialocation denisties.

Electronic Devices

Using optimized growth conditions we have obtained 2DEG mobilities of 1650 cm2/V*sec and 4400 cm2/V*sec at 300 K and 15 K, respectively. These materials have been incorporated into high electron mobility transistors (HEMTs) which displayed high transconductance (240 mS/mm), and large gate to drain break down of 340 V for Lgd = 3 microns. By using improved thermal management and alternative substrates like SiC large increases in output power have been obtained. AlGaN/GaN HEMTs grown on sapphire have improved to 4.6W/mm power density at 6Ghz, and 6.5W/mm at 6Ghz for devices on semi-insulating SiC wafers. [2] These results clearly show that GaN devices can be considered for high power, high frequency microwave radar and communication links. The authors gratefully acknowledge the support of AFOSR and ONR (C. Wood, J. Zolper) for their support of the nitride research.

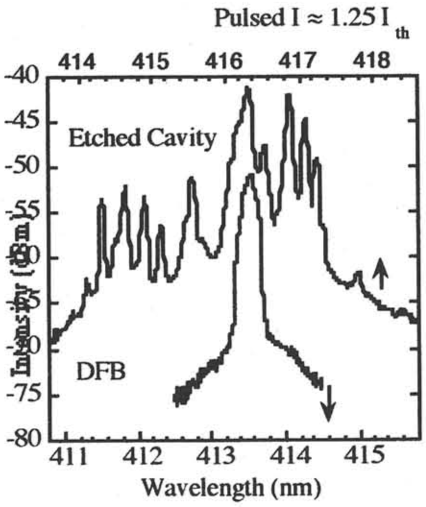

Figure 1. DFB Lasers made by MOCVD lateral regrowth over grating show narrow single mode emission in comparison to etched cavity structure.

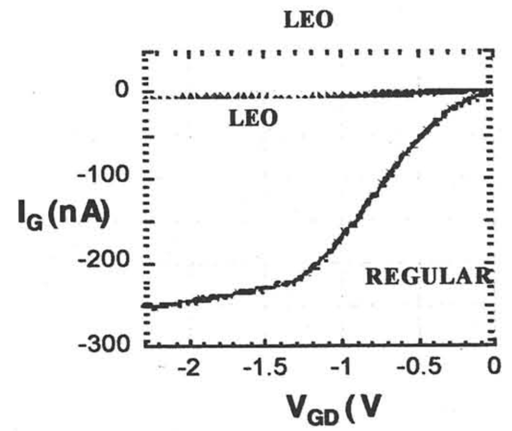

Figure 2. AlGaGn/GaN HEMT structures on LEO show significant reduction in gate leakages current.

REFERENCES

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2. Wu, Y.-F.; Thibeault, B.J.; Keller, B.P.; Keller, S.; Denbaars, S.P.; Mishra, U.K. 56th Annual Device Research Conference Digest (Cat. No.98TH8373), *New York, NY, USA: IEEE, 1998. p.118-19.*