

Selective Area Growth of Gallium Nitride via Metal Organic Vapor Phase Epitaxy

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Abstract

Gallium nitride (GaN) is a promising wide band gap semiconductor for use in a number of electronic and optoelectronic applications. The wide band gap makes the material suitable for applications in which emission in the blue or ultra violet region is required, such as solid state lighting or biological detection. Additionally, the high electron saturation velocity and high breakdown field make the material suitable in high frequency and high power applications¹. Extensive research efforts have focused on means of improving the quality of GaN by lowering the dislocation density and thus improving the lifetime and efficiency of devices made from this material. A few of these techniques, such as facet controlled epitaxial lateral overgrowth², are heavily dependant on the selective area growth (SAG) of GaN, and therefore, a complete comprehensive model would allow us to utilize this technique further. Additionally, a model would allow us to engineer the three dimensional structures that arise from the SAG of GaN for direct implementation in device fabrication.

In this work, we investigated the effect various growth parameters on the SAG of GaN grown via Metal Organic Vapor Phase Epitaxy. SAG was carried out on a striped dielectric pattern oriented along the GaN $\langle 1\bar{1}00 \rangle$ direction. All growths were stopped prior to coalescence and the cross sections of the resulting structures were characterized using scanning electron microscopy. Growth parameters investigated include temperature, V/III ratio, and gas flow^{3,4}. The variation of temperature and V/III ratio gave rise to various cross sectional geometries, including trapezoids and squares, and growth rates. The effect of gas flow was studied by performing the SAG of GaN with no rotation in the horizontal reactor. Growths were performed with the striped dielectric pattern oriented both parallel and normal to the incoming gas flow. The samples with the striped pattern oriented normal to the incoming gas flow experienced enhanced vertical and cross sectional growth rates as compared to the samples with the pattern oriented normal to the gas flow. The combined effects of the mentioned growth parameters can be utilized in the dislocations reduction techniques and also for the engineering of the three dimensional structures to be used in device fabrication.

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