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Influence of substrate nitridation on the threading dislocation density of GaN grown on 200 mm Si (111) substrate

Abdul Kadir[a], Saurabh Srivastava[a], Zhang Li[a], Kenneth Eng Kian Lee[a], Wardhana A. Sasangka[a], Silvija Gradecak[a,c], Soo Jin Chua[a,b] and Eugene A. Fitzgerald[a,c]

[a]*Singapore-MIT Alliance for Research and Technology, 1 CREATE Way, 138602, Singapore*

[b]*National University of Singapore, Engineering Drive 3, 117576, Singapore*

[c]*Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

**abdulkadir@smart.mit.edu*

ABSTRACT

High quality GaN was grown on 200 mm Si (111) substrates by using AlN and 3 step-graded $Al_xGa_{1-x}N$ as the buffer layer in a metalorganic chemical vapor deposition system. We have investigated the influence of NH_3 pre-flow time on the threading dislocation density (TDD) of AlN, AlGaN buffer layers and GaN layers. It was observed that the compressive stress introduced into the buffer layer and GaN is dependent on the nitridation time. The lowest TDD for GaN obtained in our samples was ~1 $\times 10^9$ cm^{-2} for screw type and 3.2 $\times 10^9$ cm^{-2} for edge type dislocations, as obtained from atomic force microscopy and further confirmed by high resolution x-ray diffraction analysis. The threading dislocations generated in the first buffer layer (AlN) during its nucleation are found to influence the TDD in the subsequent layers. Samples without an intentional nitridation step exhibit higher TDD compared to the samples with optimal nitridation time. Longer nitridation time also leads to poor crystalline quality likely because of amorphous SiN_x formation at the interface.

Keywords: Gallium nitride; Silison (111); Nitridation; Silicon nitride; Metal-organic chemical vapor deposition; High-resolution X-ray diffraction; Atomic force microscopy; Defect Density.

* Corresponding Author: email: abdulkadir@smart.mit.edu

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