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The influence of LT-GaN buffer layer on the residual stress of GaN film using AlN buffer layer on Si(111) substrate

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Gallium Nitride(GaN) is a wide bandgap semiconductor and has been considered as a very promising optoelectronic material for the applications to various devices such as light-emitting-diode and laser-diode in the deep ultraviolet region. Despite of its excellent optoelectronic properties, the growth of GaN is complicated by lack of a lattice matched substrate material. Recently, research on the growth of GaN on Si substrate has been investigated for combining GaN based optoelectronic devices and Si-based electronic devices. However, direct growth of GaN on Si(111) is very difficult due to poor nucleation, leading to the introduction of AlN or GaN buffer layer [1].

In this study, the influence of low temperature GaN (LT-GaN) buffer layer on the residual stress of GaN film grown on Si(111) substrate with AlN buffer layer was investigated. AlN buffer layer was grown by metalorganic chemical vapor deposition(MOCVD) at 1020℃ with trimethylaluminum and ammonia as source gases. The growth temperature of LT-GaN buffer layer was changed from 525℃ to 900℃.After the substrate surface was thermally cleaned under nitrogen and nitridation by ammonia, LT-GaN was grown at various temperature from 500℃ to 750℃. And then, the substrate temperature was ramped to the growth temperature of 1060℃. GaN films were grown on AlN/Si(111) substrates by atmospheric MOCVD in horizontal reactor using nitrogen carrier gas.

For the growth characteristics of GaN film epitaxially grown on Si(111) under different growth condition including growth temperature of LT-GaN buffer layer, scanning electron microscopy (SEM), Raman spectroscopy, Photo luminescence(PL),and transmission electron

microscopy(TEM) were employed. In Raman measurement, the residual stress was calculated by the frequency shift of the E2 phonon mode of GaN film with respect to that of bulk GaN (ω=587/cm^{-1}). From this study, we can find the optimized temperature of LT-GaN buffer layer grown on AlN/Si(111) substrate. This result was proved by analysis the mircostructure of GaN films.

[1] A.M. Sanchez, S.I. Molina, P. Ruternan, F.J. Pacheco, S.I. Molina, and R. Garcia, Appl. Phys. Lett. 79, 3588 (2001)