# Abstract

III-Nitrides (AlN, GaN, InN) find use in the high-power high frequency applications. Bulk GaN substrates are difficult to grow, therefore the GaN based structures must be grown on foreign substrates.

In this thesis, microstructural evolution of Gallium Nitride grown by Metal Organic Chemical Vapour Deposition (MOCVD) process on c-plane sapphire substrate has been systematically studied using transmission electron microscopy (TEM) and related spectroscopic techniques. The role of nitridation temperature, its effect on GaN film for the subsequent growth processes has been analyzed.

The first step in the growth process is the nitridation of the sapphire layer. It has been observed, that under low temperature (at 530$^{o}$C) nitridation, an AlON complex with a cubic structure is formed and at higher nitridation temperatures (> 800$^{o}$C), AlN with a cubic structure is formed. The crystallography and orientation of the nitrides are defined.

The low temperature GaN nucleation layer grown on these nitride layer templates have also been studied and it has been observed that zinc blende-GaN is the majority phase for low temperature nitridation and wurtzite-GaN forms for the higher temperature nitridation. The continuity, mosaicity, and crystallography of these low temperature GaN films have been characterized in the as grown and thermally annealed conditions.

Subsequent high temperature GaN films grown on these templates are found to contain Ga-polar GaN and N-polar GaN as the majority phases for the low and high temperature nitridation cases, respectively. Dislocations, stacking faults and inversion domains present in these high temperature GaN films affect the properties of the device as a whole, and have been studied. The differences in the defect structures in Ga-polar GaN and N-polar GaN epilayers are described.