Transmission Electron Microscopy study of a GaN thin film grown on Al_2O_3 by MOCVD

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Abstract

For this work a structural study of the GaN/Al_2O_3 heteroepitaxy was carried out by Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). A GaN thin film grown on the c-plane of an Al_2O_3 substrate by MOCVD was characterized. The sample was observed by AFM and SEM, the analysis showed the GaN formed hexagonal-like features on the surface of the sample. An abrupt interface was observed in the TEM cross section images. Results showed GaN with excellent structural properties was grown.

Introduction

GaN-based laser diodes and light emitting diodes in the UV-blue region have been developed at commercial scale [1-3]. With the lack of a suitable substrate these devices were designed on the GaN/Al_2O_3 heteroepitaxy fabricated by sophisticated techniques like Metal Organic Chemical Vapor Deposition (MOCVD). The difference in lattice parameters and thermal expansion coefficients in the heteroepitaxy produce dislocations in the order of 10^9-$10^{11}cm^{-2}$ [4]. In spite of this fact optoelectronic devices reached the market. However for the next generation devices a considerable reduction in dislocations densities must be achieved [4]. For this reason studies oriented to evaluate the crystalline and structural quality of the GaN/Al_2O_3 system are necessary. For this work a GaN thin film grown on the (0001) c-plane of an Al_2O_3 substrate was characterized by Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy and Room Temperature Photoluminescence. Results showed an abrupt interface was obtained an indication of a high quality GaN epilayer which exhibited intense excitonic emission at room temperature

Experiment

The GaN films were grown by MOCVD with the conventional two steps mode. The first step consisted of a GaN buffer layer at low temperature of 530 ºC for 15 minutes; the second stage was the growth of a GaN film at 900 ºC for a period of 120 minutes. Trimethylgallium (TMGa) and ammonia (NH_3) were used as precursors and high purity hydrogen (H_2), from a palladium membrane filter, as the carrier gas.

Results

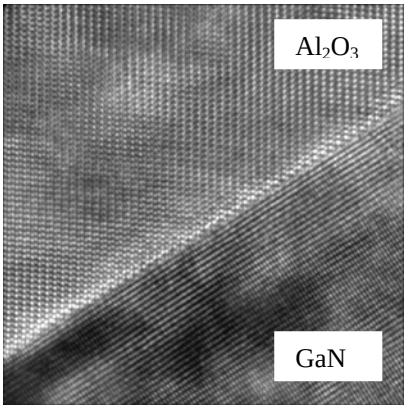

Fig. 1. A high resolution TEM image af a GaN thin film grown on Al_2O_3 substrate. Note the abrupt interface.

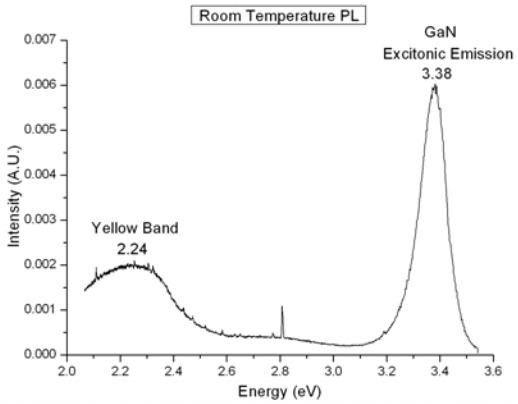

Fig. 2. The sample presents high crystalline quality as proved by the excitonic PL emission at room temperature.

References

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