doi: 10.1017/S1431927609099012
Microsc Microanal 15(Suppl 2), 2009

Stress Modulated Composition Fluctuation and Diffusion in near lattice match AlInN/GaN

Anas Mouti[1], Jean-Luc Rouvière[2], Nicolas Grandjean[3], Pierre Stadelmann[1]

[1] Interdisciplinary Center of Electron Microscopy (CIME), Swiss Federal Institute of Technology (EPFL)
[2] CEA Grenoble, Department of Fundamental Research on Condensed Matter
[3] Laboratory of Advanced Semiconductors for Photonics and Electronics (LASPE), EPFL

AlInN is growing in importance as a high band gap semiconductor alloy because of its ability to be lattice matched to GaN and thus reduce defect creation in Group III based photonic devices.

We report the study of stress driven composition modulation and diffusion in AlInN/GaN. The studied AlInN layers are grown on a micron thick GaN buffer layer grown on sapphire. Due to the high lattice mismatch between GaN and Sapphire, dislocations generate at the GaN/Sapphire interface and some of them propagate along the growth direction, forming what are called threading dislocations (TD). AlInN grown on the GaN buffer therefore inherits the stress fields of the TDs.

One of our approaches involves studying composition distribution around TD in AlInN and compare them to calculations based on a Maxwell-Boltzmann model (Fig.1) to predict hydrostatic stress driven composition. Experiments involved STEM EDX (Fig.2) as well as Cs corrected STEM HAADF. We show that in regions of low disorder (low dislocation density), Indium Nitride, due to its higher lattice parameter tends to occupy regions of tensile stress, while Aluminum Nitride tends to regions of compressive stress, in good agreement with theory. We also show that TDs act as diffusion short circuits for GaN, which tends to replace Indium in regions of highly compressive stress (near dislocation cores). We provide as well strong evidence that Gallium Nitride diffusion is responsible, at least in some cases, fore the pit formation at the points of emergence of TDs, in contradiction with the widely assumed fact that InN is responsible for it [1].

Strained AlInN/GaN layers have also been studied by STEM/EDX, and show a far more considerable gallium diffusion into AlInN. This latter fact is characteristic of stress driven diffusion.

References

1. Surface energetics, pit formation, and chemical ordering in InGaN alloys: J. E. Northrup, L. T. Romano, and J. Neugebauer, Appl. Phys. Lett. 74, 2319 (1999)

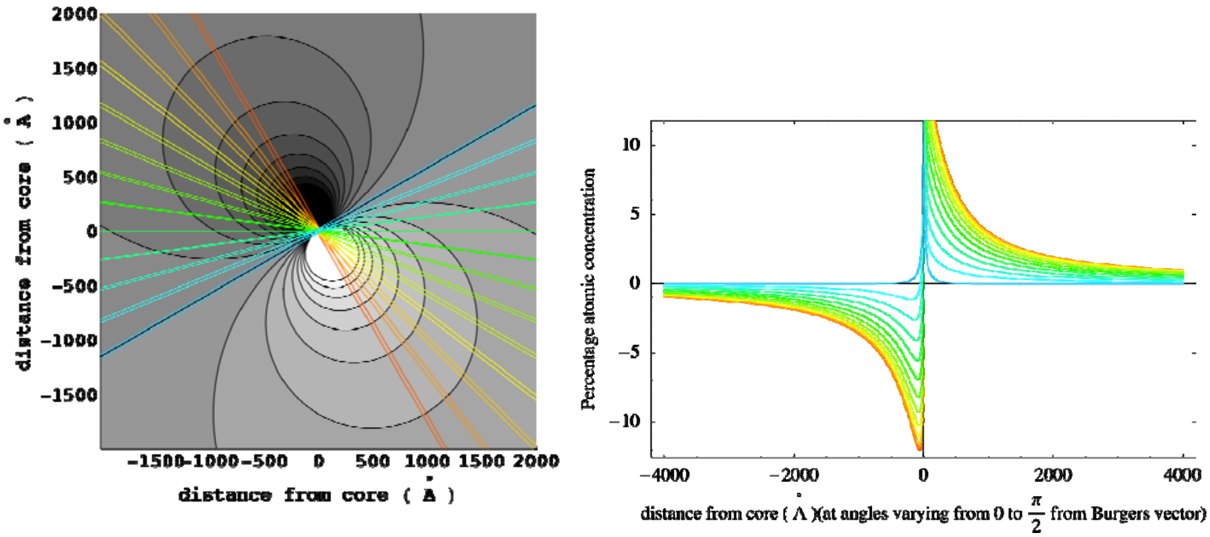

Figure 1: Plan View (right) and cross sectional calculated indium fluctuation near a edge component Threading Dislocation

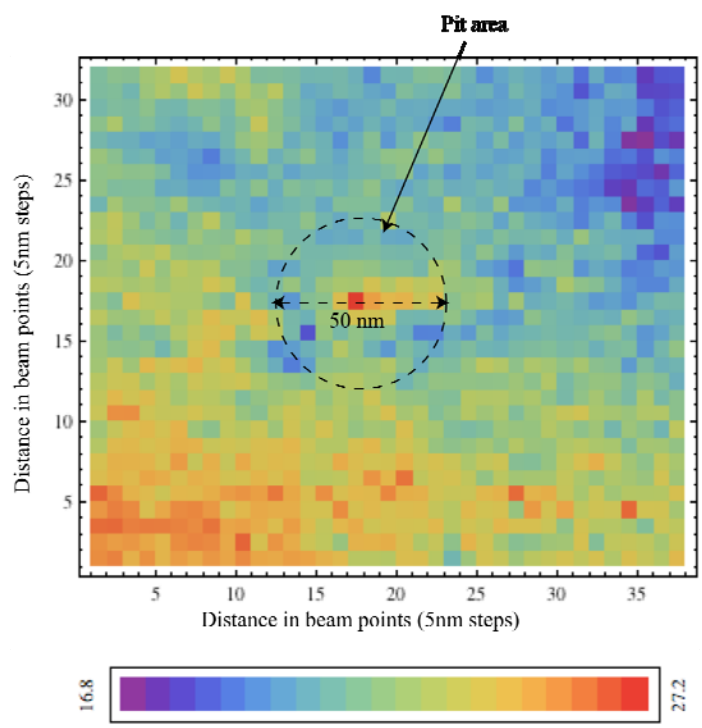

Figure 2: Plan View EDX map of Inium distribution around an edge component Threading Dislocation

https://doi.org/10.1017/S1431927609099012 Published online by Cambridge University Press