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InGaN Growth Morphology and Its Relationship to Luminescence for Solid State Lighting DANIEL D. KOLESKE¹, Sandia National Laboratories

It has been suggested that InGaN quantum well (QW) thickness fluctuations, acting in conjunction with piezoelectric fields, are sufficient to produce exciton localization and reduce non-radiative recombination at dislocations.² Consequently, the study of InGaN step morphology and the control of InGaN/GaN interfaces may be crucial for understanding and improving blue and green LED quantum efficiency. To this end, a variety QW and thin film structures have been grown to determine how the surface roughens when indium is alloyed with GaN. Statistical analysis of the step height distributions from AFM images shows that the nominally single-layer step heights transition to multiple-layer step heights as InGaN is grown on GaN. Further analysis of the surface-roughness power spectral density suggests that the main smoothing mechanism changes from evaporation/recondensation for GaN growth to surface diffusion for InGaN growth. Exploiting two smoothing mechanisms allows the construction of otherwise identical MQW structures with smoother or rougher InGaN QWs. Initial studies of the correlations between QW interface roughness and luminescence intensity suggest that some degree of InGaN QW roughness leads to higher luminescence efficiency, lending credence to theories that propose a structural-based enhancement of exciton localization.³

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²D. M. Graham, et al., J. Appl. Phys. 97 103508 (2005).

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