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Studies of Enhanced Internal Quantum Efficiency of Photoluminescence from $Al_xGa_{1-x}N$ Alloys Displaying Nanoscale Compositional Inhomogeneities

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— AlGaN epilayers, grown by plasma-assisted molecular beam epitaxy, show internal quantum efficiency (IQE) for photoluminescence (PL) much higher than expected for growth on sapphire where high defect densities ($> 10^{10}$ cm^{-2}) are generated. Results are similar to earlier successes seen in blue- green light emitting diodes (LEDs) incorporating InGaN active regions where carrier localization is seen due to indium segregation. With no predicted immiscibility gap for aluminum in GaN and no observed aluminum segregation, the IQE increase in our AlGaN layers is attributed to localization of carriers to regions of nanoscale compositional inhomogeneities (NCI) that inhibit movement of carriers to nonradiative sites. Sub- picosecond time-resolved PL, using gated downconversion in a nonlinear optical crystal, is used to measure carrier capture dynamics from the bulk epilayers into these NCI regions. Rate equation modeling is used to estimate the density of NCI regions and to help understand the observed changes in IQE for NCI AlGaN epilayers grown under different conditions.

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