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Effects of morphology on the emission of photons from GaN membranes fabricated using surface charge lithography

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Abstract

Cathodoluminescence (CL) microanalysis has been used to investigate ultra-thin suspended GaN membranes fabricated from GaN epilayer surfaces by focused ion beam (FIB) pre-treatment and subsequent photoelectrochemical (PEC) etching. The analysis of the spectral and spatial distribution of the emitted photons from GaN nanomembranes gives insight into the technologically important physical properties which are strongly influenced by microstructural defects associated with dopants and native defects. CL emission is associated with key features of the GaN nano-membranes including the suspended nano-membranes, the etch-resistant ion beam implantation support structures, etch-resistant dislocation-related whiskers and the underlying regions of etched GaN. Monochromatic CL images show that suspended nano-membranes emit ~3.4 eV photons which at 295 K are associated with free exciton transitions, and ~2.2 eV photons which are associated with defects related to implantation induced deep acceptor states. Blue shift of the CL near band edge emission at ~3.4 eV indicates that the suspended GaN nanomembranes exhibit the combined effects of quantum confinement and compressive strain.