Supporting Information

Effect of Thermal Annealing in Ammonia on the Properties of InGaN Nanowires with Different Indium Concentration

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Figure S11. HAADF STEM images of as grown and annealed In$_x$Ga$_{1-x}$N nanowires. HAADF STEM images of (A-D) as grown and (E-H) annealed nanowires show the instability of In$_x$Ga$_{1-x}$N nanowires with from increasing the indium composition. Significant surface etching was observed for samples (C,G) $x = 0.28$ and (D,H) $x = 0.42$ after annealing. Scale bar = 20 nm.
Figure SI2. XRD spectra of as grown and annealed In$_x$Ga$_{1-x}$N nanowires. (A) High angle wurtzite 103 and 201 diffraction peaks for sample $x = 0.17$ show no peak splitting after annealing, indicating that lower indium composition nanowires are phase stable. (B) The XRD spectrum for sample $x = 0.42$ reveals In$_x$Ga$_{1-x}$N wurtzite (blue) and In tetragonal (red) peaks, showing that nanowires decompose into In metal during the annealing process. (C) The high angle wurtzite 103 peak for sample $x = 0.42$ splits into multiple peaks after annealing at 800°C, indicating that higher indium composition In$_x$Ga$_{1-x}$N nanowires are metastable and phase separate at high temperatures.

Figure SI3. HRTEM image of sintered InGaN nanowires. The HRTEM image shows a clear shift in lattice orientation from the bottom nanowire to the top nanowire, indicating that as grown InGaN nanowires are likely tilted/twisted in orientation from mosaic
growth. As a result, an increase in dislocation density can be seen at the interface of sintered InGaN nanowires (dashed area).

**Figure S14.** PL spectra of as grown and annealed In$_x$Ga$_{1-x}$N nanowires. PL spectra for sample $x = 0.07$ show that the intensity of band-edge PL increases with annealing temperature.
Figure SI5. Color PL images of as grown and annealed In$_x$Ga$_{1-x}$N nanowires. Color PL images of as grown samples (A) $x = 0.07$, (B) $x = 0.17$, (C) $x = 0.28$, and (D) $x = 0.42$ demonstrate the ability to tune the emission wavelength with indium composition. (E-H) The corresponding annealed nanowire arrays increase in intensity from an improvement in QE. (G,H) The PL of higher indium composition arrays changes in color from indium etching.

Figure SI6. Time-resolved PL spectra of as grown and annealed In$_x$Ga$_{1-x}$N nanowires. Time-resolved PL spectra of as grown and annealed samples (A) $x = 0.28$ and (B) $x = 0.42$ show fast initial decay of the PL intensity. The majority of the signal is limited by the instrument response function (shown in black).