Imaging the carrier confinement within a single nanowire

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The assembly of group-III nitride nanowires into optoelectronics offers a promising approach to improve the performance of light-emitting devices. Two dimensional quantum confinement effects, created by coaxial band structure engineering, lead large spectral tunability and high luminescence quantum yields. Sophisticated core/multishell nanowires have already been designed to produce a large variety of size-dependent phenomena for advanced light-emitting diodes. Although theory suggests that the carrier distributions in nanowires exhibit two dimensional confinement under a cross-section of hexagonal geometry, its direct observation has never been addressed. By combining synchrotron excited optical luminescence with simultaneous energy-disperse X-ray spectroscopy using a nanometre-sized hard X-ray beam, here we show experimental evidence for these carrier localization effects. Applied to single coaxial n-GaN/InGaN multiquantum-well/p-GaN nanowires, our hyperspectral imaging method reveals a stronger transition at the hexagon corners, matching theoretical predictions. Based on core-level excitation processes, our experiment opens new avenues for further local structure, and time-resolved studies with both nanometre resolution and optical sensitivity. We anticipate that this methodology will contribute to a greater understanding of the underlying design concepts of photonic nanodevices.