



From the journal:

Journal of Materials Chemistry C

GaAsPN core-shell nanowire-based red microLEDs overcoming the efficiency cliff problem

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Abstract

Light emitting diodes (LEDs) based on III–V semiconductors are in great demand for many applications and tend to be miniaturized. However, with downscaling of planar LEDs, the surface states on the structure sidewalls, acting as nonradiative recombination centers, begin to play a significant role and deteriorate the device performance. The transition from planar to nanowire-based geometry helps to overcome this limitation. Here, we introduce a bottom-up microLED structure based on epitaxial GaP/GaAsPN/GaP nanowire arrays grown on low-cost Si(111) wafers. The active region demonstrates bright photoluminescence in the red spectral region while the radial p–i–n structure allows for electrical pumping. The opto-electrical characteristics and performance of the suggested microLEDs remain with the miniaturization of the devices down to microscale equivalent lateral size. Moreover, we didn't observe an efficiency cliff even for current density exceeding 300 A cm^{-2} . The proposed architecture paves the way to a new generation of nanowire-based microLEDs.

