

Quantum Light Emission from GaAs_xP_{1-x} Quantum Dots in Wurtzite GaP Nanowires

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Tunable single-photon emitters in nanowires (NWs) are promising building blocks for compact quantum photonic devices. Among III–V semiconductors, GaP combines a broad transparency window (0.6–11 μm) with a small lattice mismatch to silicon and, in the wurtzite (WZ) phase, a pseudo-direct bandgap of 2.18–2.25 eV.[1] Alloying GaP with GaAs enables bandgap engineering, and thus tunable light emission, across the green-to-red spectral range (550–820 nm),[2] a spectral window particularly relevant for quantum technologies, including free-space quantum communication, where reduced atmospheric attenuation and compatibility with existing silicon-based single-photon detectors are important practical advantages.

We present a novel platform for quantum light generation based on WZ GaAs_xP_{1-x} quantum dots (QDs) embedded in defect-free WZ GaP NWs. By varying the QD composition between $x = 0.7$ and 0.9 , the emission wavelength can be tuned from approximately 630 to 700 nm. Power- and temperature-dependent micro-photoluminescence measurements reveal well-resolved excitonic lines with linewidths below 2 meV up to 70 K.[3] Electronic band structure calculations reproduce the dependence of the QD emission energy on alloy composition and QD size, providing a framework for controlling the optical response.

Second-order autocorrelation measurements demonstrate high-purity single-photon emission, with $g^{(2)}(0) = 0.090 \pm 0.001$ under pulsed excitation at 5 K. Antibunching is also observed under continuous-wave excitation from 5 to 40 K. Time-resolved measurements yield sub-nanosecond lifetimes.[4] These results establish WZ GaAs_xP_{1-x} QDs embedded in GaP NWs as a compositionally tunable platform for single-photon generation, combining emission in the visible range with operation at comparatively relaxed cryogenic temperatures and offering a promising route towards integration into scalable quantum photonic devices.

References

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