Engineering Telecom-Wavelength Quantum Dots via Epitaxial Growth on InP and GaAs for Single-Photon Applications

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This work explores two promising approaches for fabricating single-photon emitters operating at telecom wavelengths (1.3–1.55 μm), using epitaxially grown quantum dots (QDs). The first approach involves the growth of InAs nanostructures on InP substrates, producing a mix of quantum dots and dashes. On standard InP (100) substrates, growth proceeds via a modified Stranski–Krastanov (SK) mechanism, where a thick, planar wetting layer forms prior to 3D island nucleation. These elongated dashes, preferentially aligned along the (1-10) direction, exhibit limited three-dimensional confinement, behaving more like quantum wells. In contrast, growth on (311)B-oriented InP yields discrete QDs with strong single-dot emission characteristics.[1]

The second approach leverages the GaSb/GaAs material system to realize both coherently strained SK-mode QDs and strain-relaxed islands, the latter mediated by interfacial misfit dislocation arrays. Despite its promise, this system faces challenges due to likely type-II band alignment and the complexity introduced by GaSb/GaAs interdiffusion during capping.

Growth experiments are conducted using a solid-source VG V80 MBE reactor. InAs QDs are deposited on n-doped InP (001) and (311B) substrates with $In_{0.53}Ga_{0.47}As$ buffer layers, while GaSb QDs are grown on semi-insulating GaAs (001) with GaAs buffer layers. Substrate desorption, growth temperatures, and layer thicknesses are carefully optimized. Ongoing work includes detailed PL, μ-PL, and TEM characterization of these nanostructures to assess their optical and structural properties for single-photon emission applications.

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[1] N. A. Jahan et al., Temperature dependent carrier dynamics in telecommunication band InAs quantum dots and dashes grown on InP substrates, J. Appl. Phys. **113**, 033506 (2013).