

Designs of 1.3 μm InAs-InGaAs Quantum Dot VCSELs on GaAs Substrates for Higher Optical Power Emission

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In this *Longwave on GaAs Workshop* we discuss our current work on increasing the output power of GaAs-based, 1.3 μm -emitting, quantum dot (QD) vertical cavity surface emitting lasers (VCSELs). The aim is to investigate the range of possible and practical output powers for these longer wavelength microlasers. The structures are grown by molecular beam epitaxy (MBE) wherein we typically employ conventional AlGaAs ($x = 0.0$ and 0.9) distributed Bragg reflectors (DBR) with “graded-layer” interfaces by means of digital chirped superlattices. We investigate VCSELs with both all-semiconductor, doped DBRs and also VCSELs containing combinations of doped-semiconductor and nonconducting GaAs/ AlO_x or GaAs/ AlGaO_x DBRs. We continue to investigate both conventional and intracavity-contacted top emitting VCSELs, all containing AlGaO_x current apertures with diameters of 10 to over 50 μm . In later work we plan to also utilize heat sinking and related packaging techniques to further increase the output power.

In our related work on stripe-geometry, quantum dot edge-emitting laser diodes we have studied active regions composed of stacked sheets of InAs/InGaAs QDs. The typical growth sequence for 1.3 μm QDs on (100) GaAs substrates by molecular beam epitaxy includes an ~ 0.8 nm-thick InAs layer, followed by an ~ 4 nm-thick $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$ layer, and followed by a 20 to 30 nm-thick GaAs layer. We can readily repeat this sequence of layers up to 10 times. In our 1.3 μm QD VCSELs on GaAs, we typically employ up to five stacked sheets of dots to keep all of the dots within the central anti-node of the fundamental optical (standing-wave) mode. During the Workshop we will discuss our optimization studies of the design of the QD microcavity active region and the physical geometry of the VCSELs.