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Single mode operation in ultra-short cavity Quantum Cascade lasers[1] RICHARD CENDEJAS, Princeton University, WENDY SANCHEZ-VAYNSHTEYN, City University of New York, DONGXIA QU, CLAIRE GMACHL, Princeton University — Single-mode continuous wave operation of a λ=5.3 μm Quantum Cascade laser (QCL) is achieved through the systematic shortening of the cavity length of ridge waveguide QCLs with lengths ranging from 800 to 100 μm. Increasing mirror loss was mitigated with highly reflective metallic facet coatings. With smaller cavity lengths, the power consumption of an ultra-short cavity QCL of 110 μm is $\sim$250 mW at 80K, or about 20 times lower than conventional QCLs. Shortening the cavity length increases the free spectral range of the longitudinal modes placing the side modes at the edge of the gain profile, thus deliberately reducing the number of lasing modes until single-mode operation is achieved. The dominant mode is placed on the gain peak via temperature tuning, increasing the gain margin between the dominant and side modes, further increasing the single-mode current range. Amplified spontaneous emission spectra at various temperatures show that an initial gain margin increase from 1.5:1 to 2:1 doubles the single-mode current range. Ultra-short cavity QCLs with lengths of 110 μm are shown to operate single mode with the best device having a 10 cm^{-1}single-mode continuous tuning.

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