

Room Temperature Continuous Wave Operation of an External Cavity Quantum Cascade Laser

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Abstract: Room temperature, continuous wave (CW) operation of an External-Cavity Quantum Cascade Laser (EC-QCL) is reported. Single mode tuning range of 120 cm^{-1} was achieved, from $7.96\text{ }\mu\text{m}$ to $8.84\text{ }\mu\text{m}$. The gain chips utilized are based on the bound to continuum design and were fabricated as buried heterostructure lasers. Mode-hop free tuning (hopping on extended cavity modes) is demonstrated for an Anti reflection (AR) coated laser, just by grating rotation. The EC-QCL was implemented in a Littrow setup and a peak power of 1.5 mW was obtained at the maximum of gain curve, a peak power of over 20 mW was obtained for a modified Littrow setup with backside extraction of light.

Quantum cascade (QC) lasers have become interesting sources in the Mid-IR and Far-IR spectral range since their inception in 1990 [1]. The recent developments in the mid-IR QCLs mean they can deliver high optical power (up to several hundreds of milli-watts) at room temperature [2]. QCLs are emerging as strong contenders in the field of high resolution spectroscopy esp. in the (mid-IR) molecular fingerprint region, tunable quantum cascade lasers (QCLs) have proved to be convenient and reliable light sources for the spectroscopic detection of trace gases [3].

Spectroscopic applications usually require single mode operation. This is usually achieved by introducing a distributed feedback (DFB) structure into the QCL active region or by using an external cavity setup. Grating-tuned EC-QCLs can deliver single-mode radiation and are tunable in excess of 200 cm^{-1} [4], in comparison to the DFB QCLs that provide tuning in the order of $10\text{-}15\text{ cm}^{-1}$ [5]. The major drawback of the lasers in [4], which worked in pulsed mode on a thermoelectric cooler (TEC), was the relatively poor side-mode suppression ratio (SMSR). The continuous wave operation of EC-QCL helps suppressing these parasitic modes.

We report the CW operation of room temperature EC-QCL at technologically important $8.4\text{ }\mu\text{m}$. Figure 1 shows single mode tuning of 120 cm^{-1} with a SMSR $< -30\text{ dB}$. Figure 2 shows the LIV curves of the EC-QCL implemented in the Littrow configuration and the modified Littrow setup with the backside extraction of light.

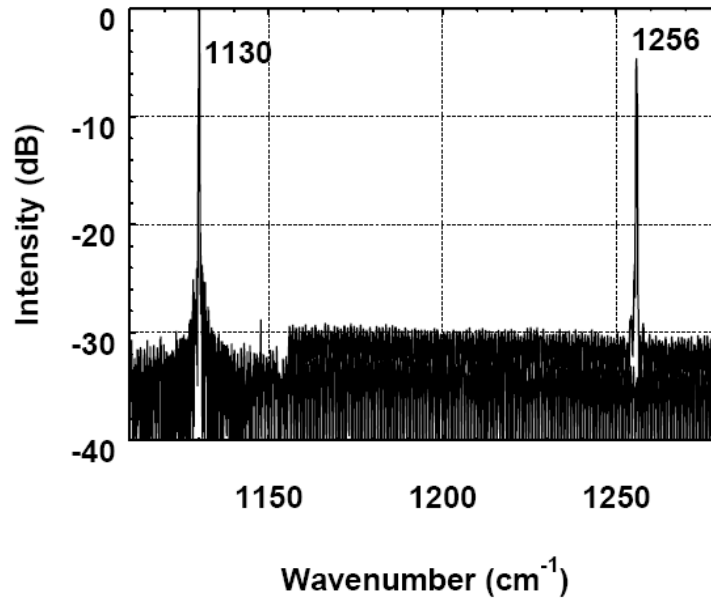


Figure 1 : Broadband tuning of 120cm^{-1} of the EC-QCL with a SMSR $< -30\text{dB}$.

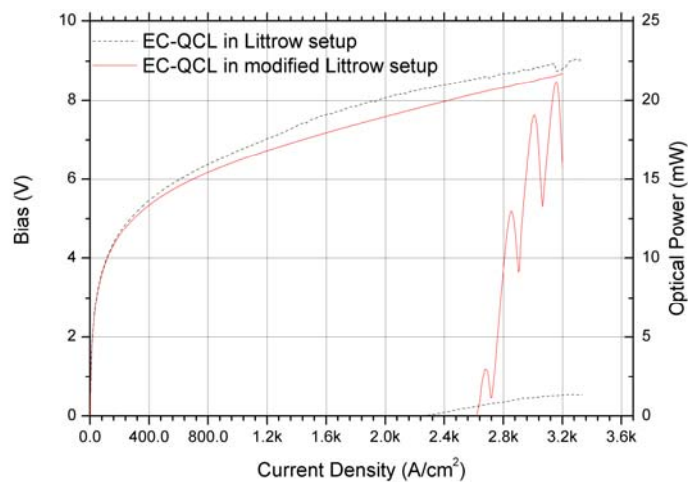


Figure 2: EC-QCL emission as a function of the current at 20°C and current-voltage characteristics. Output powers of 1.5 mW were reached in the conventional Littrow setup whereas 20mW output powers were reached in the modified Littrow setup. The strong oscillations are due to the chip-modes which show up due to a worse AR-coating.

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