

## External Cavity for QCL installed in Mid-Infrared Laser Heterodyne Instrument

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### **Abstract**

Tuneable quantum cascade laser (QCL) for a room temperature operation great expands accessible molecules of atmospheric and astronomical interest. Very recent study presents an excellent broad gain QCL with a tuning of over 400 cm<sup>-1</sup> from 7 to 11 micron wavelength with an averaged output power of 15 mW at room-temperature [Hugi *et al.*, 2009]. Single-frequency operation of the source by use of external cavity potentially provides a great powerful tool for spectroscopic applications. The purpose of this study is to develop the external cavity setup for QCL as local oscillator for mid-infrared laser heterodyne spectroscopy [e.g., Sonnabend *et al.*, 2008; Stupar *et al.*, 2008].

We have developed the external cavity system for QCL at mid-infrared wavelengths for use as a local oscillator in a heterodyne receiver. Frequency selective feedback is achieved using a diffraction grating in a Littrow configuration. The multi-mode emissions are suppressed to be single-mode by optical feedback using an external cavity. An essential requirement for maximum efficiency of the external cavity is precise mode matching between laser and external cavity, i.e., the positioning accuracy of the collimating optics. Using FTIR, we adjusted the grating vertical and horizontal angles to select the wavelength, maximize the feedback, and achieve single-mode operation.

The side mode suppression is due mainly to the higher selectivity of the QCL cavity without an AR coating, which suppresses oscillations of nearby EC modes. The position of each mode does not significantly vary with the laser current. Temperature tuning is able to shift each mode frequencies, and allow a complete frequency range to be covered with the external cavity QCL.

Our result demonstrated that a compact external-cavity QCL system was well suited to be used as a local oscillator in mid-infrared laser heterodyne instrument. It was shown that the spectral stability, side mode suppression, and narrow linewidth are excellent.