Wavelength stabilized External Cavity Quantum Cascade Lasers using CRIGF filters

A. Monmayrant,[1] S. Augé,[1] G. S. Gluchko,[2] A.-L.. Fehrembach,[3] E. Popov,[3] T. Antoni,[4] S. Pelloquin,[1] A. Arnoult,[1] G. Maison,[5] and O. Gauthier-lafaye[1]

1. LAAS-CNRS, Université de Toulouse, CNRS, Toulouse, France

2. Laboratoire EM2C, CNRS, CentraleSupélec, Université Paris-Saclay, 3, rue Joliot Curie, 91192 Gif-sur-Yvette cedex, France

3. Aix-Marseille Univ, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France

4. Laboratoire de Photonique Quantique et Moléculaire, CentraleSupélec, ENS Paris-Saclay, CNRS, Université Paris-Saclay, Grande Voie des Vignes, 92290 Châtenay-Malabry, France

5. Mirsens

External cavity diode lasers (ECDLs) are a standard way of building single-mode and narrowlinewidth sources [1], while keeping the intrinsic benefits of the semiconductor lasers such as compactness, low cost and high-modulation capability in amplitude and frequency. Traditional ECDLs design uses a bulk diffraction grating in Littrow or Littman/Metcalf configurations. In this paper, we report on the use of recently demonstrated MIR CRIGF filters [2] to implement an alternative configuration using a compact and stable cat's eye like configuration.

The external cavity under study is composed of a 4.5µm QCL laser grown on InP substrate with an HR coating on the rear facet and an optimized AR coating made of @@@ on the front facet. A lens with a focal length of 1.87mm images with @@times magnification the facet on a CRIGF filter used as a cavity end mirror. The total cavity length is short, estimated around @@ cm. The initial cavity alignment is straightforward thanks to the high sensitivity of the QCL gain chip to optical feedback, monitored through injection voltage. On figure 1, the different CRIGFs are clearly visible (large white rectangles arranged on two 6x10 matrices with varying geometrical parameters). CRIGFs where the central GC appears as a dark narrow vertical stripe are the one inducing the highest optical feedback in the QCL. They correspond to the CRIGFs spectrally matched with the QCL gain medium and able to stabilize the emitted frequency.

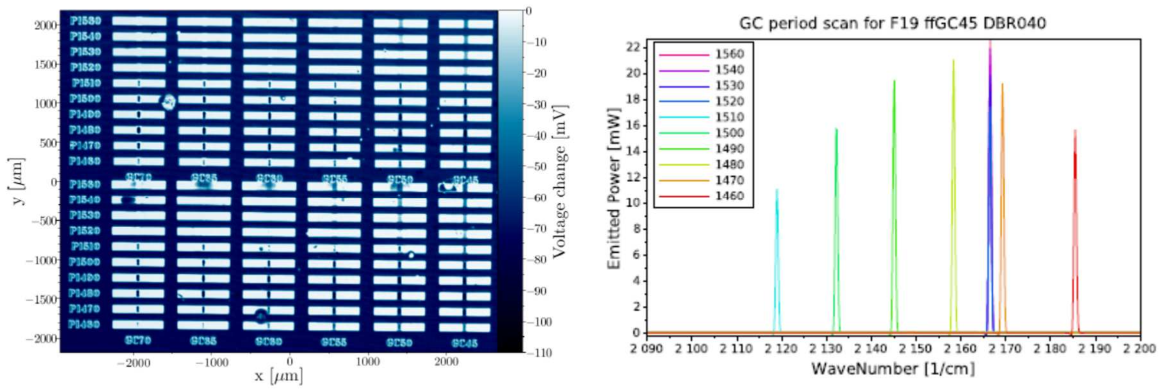

Fig. 1 Left: Change of the voltage V between QCL contacts for a fixed injection current of I= 320mA as a function of the (x; y) position of the sample in the image plane of the QCL facet. Right: emission spectra at @@ mA

After alignment, the threshold current of the cavity is around 300 mA, depending on the emission wavelength. Maximum output powers are in the range of 20mW. SMSR higher than 20dB are measured and the emission properties are compatible with a single mode emission. As depicted on the figure, the emission wavelength can be tuned over 70 cm^{-1} by changing the CRIGF period. Repetitive scanning of CRIGF filters showed an excellent wavelength repeatability, better than +-0.1 cm-1, despite with our rather crude experimental setup. Using a graded CRIGF filter [3] we obtained over the same wavelength range almost continuous tuning, limited by residual Fabry-Perot effect steaming from an imperfect AR coating on the backside of the filter.

These first results show that CRIGF filters can be efficiently used to design external cavity setups for wavelength stabilisation in the MIR of ACL lasers. Actual work focuses on the extension of the tunability range using gain chips with larger gain range.

References

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