Use of two Novel Wavelength Discriminators to determine the wavelength calibration of a Tuneable SG-DBR QCL

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Quantum cascade lasers (QCLs), are being used to monitor pollution, greenhouse gases, and in clinical diagnostics. Many of the trace gases have strong rotational-vibrational resonances in the mid-infrared (mid-IR) portion of the spectrum. These resonances behave like a DNA fingerprint, which allow them to be detected at very low concentrations in the atmosphere. Tuneable mid-infrared Quantum cascade lasers (QCLs) are now used as highly compact laser in field deployable sensors. Tuneable mid-infrared QCLs can be used to achieve high selectivity, high sensitivity and multi-species detection.

 During tuning, frequency calibration of a QCL laser can be achieved using a Fabry-Perot etalon interferometer (FPI). When the FPI reflects/transmits light, a fringe effect is created. The distance between peaks or troughs of adjacent fringes, also known as the free spectral range (FSR), allows one to calculate the change in the wavelength. This is one of the common method for wavelength calibration of tuneable lasers. The purpose of this study was to use two novel wavelength discriminators, made by Corning Incorporated and determine the wavelength calibration of a widely tuneable Sampled-Grating Distributed Bragg Reflector (SG-DBR) QCL (Fig. 1), without measuring the FSR.

The experimental setup for this study is shown in Figure 3 and Figure 4. The QCL beam propagates through the wavelength discriminator and is simultaneously reflected and transmitted and detected by detector 1 and detector 2. The data was collected via LabView and analysed using Microsoft excel. Initially the percentage of transmission was plotted against the amount of current applied to the laser. The wavelength corresponding to each current setting, was originally determined with the use of a Fabry-Perot etalon interferometer (FPI).

On both graph, Fig.4(a) and (b), the red curves do not agree with simulations and the trends seems to show an etalon effect covering valley to peak for discriminator #1 and from a peak to a valley for discriminator #2, corresponding to a FSR ≈ 2cm⁻¹. This FSR (FSR = 1 / 2nd⁻¹) matches very well the overall thickness of the GaAs discriminator substrate which is about 600µm. The noticeable fringe makes these current discriminators unsuitable for wavelength calibration.

One of the following two approaches is recommended to get a rid of the fringes:

• Design a new AR coating
• Wedge one side of discriminator

References