MAGNETO-SPECTROSCOPY OF THz DFB QUANTUM CASCADE LASERS

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Introduction

Application of a strong magnetic field perpendicular to the QW planes has proven to be a sensitive tool to study electronic structure and intersubband relaxation processes in quantum cascade lasers (QCLs) [1, 2]. In this approach, only the modification of the electronic structure of the QCL’s active zone have been exploited, while the laser cavity properties have been ignored. Here we explore the magnetic field effects on the waveguide properties of distributed feedback (DFB) single-mode THz QCLs. The possibility of continuous tuning of the emission line through the laser gain spectrum was our motivation for this experiment.

Experimental

We measured THz DFB QCLs emitting at ~100 cm⁻¹ (~3THz) at three different configurations in respect to the directions of the magnetic field, \( B \), injection current, \( j \), and emission wave-vector, \( k \): \( j \parallel B \perp k \), \( j \perp B \parallel k \), and \( j \perp B \perp k \). Emission spectra were acquired in magnetic fields up to 18T with a Bruker-66 FTIR spectrometer equipped with a FIR bolometer. The lasers were driven in pulsed mode (pulses of ~1 μs) at approximately 5 K.

Results and Discussion

THz DFB QCLs behave very differently when the magnetic field is applied perpendicular or parallel to the 2DEG planes (Fig.1). Under perpendicular field (i.e., \( j \parallel B \perp k \)), we observe strong oscillations in the laser emission intensity. These types of oscillations have been recently reported in THz QCLs [2]. The effects of a magnetic field on the properties of the DFB waveguide are expected to happen in Voigt configuration. However, the laser emission power drops very quickly, and the magnetic fields of about 0.5T completely extinguish the laser action. At such small fields, an eventual wavelength shift would hardly be larger than the line width. Indeed, we were not able to observe any change in the emission wavelength (Fig.1).

The effect of the immediate quenching induced by the in-plane field could be interesting for the physics of the THz QCL active region design. It may provide a new experimental tool to study the role of interface roughness scattering. This is known to be relevant for THz QCLs but no definite data exist.

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References