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INTERSUBBAND MAGNETOPHONON RESONANCE IN InAs/AlSb QUANTUM CASCADE STRUCTURES

G. Fedorov, A. Wade, D. Smirnov (NHMFL); R. Tessier, A. Baranov (CEM2, University of Montpellier II, France)

Introduction

The application of a strong magnetic field has proven to be a sensitive tool to study electronic structure and intersubband transitions in quantum cascade lasers (QCLs) [1, 2]. In this work we study InAs/AlSb QCLs. Due to the small effective mass in InAs, these structures can ultimately yield low laser thresholds and high operating temperatures. Also, an InAs/AlSb system is very promising for the development of short wavelength QCLs due to its higher values of conduction band discontinuity than those in more “conventional” GaAs/GaAlAs-based systems. However, an insufficient knowledge of their electronic structure and intersubband relaxation mechanisms results in poor control of antimonide-based QCLs. This information can be drawn from magneto-transport and magneto-optical experiments.

Experimental Details

Preparation and characterization of the QCL structures studied here is described in Ref. [3]. Our experiments have been done at the SCM-2 facility and at the 30T/32mm bore resistive magnet facility. Spectral measurements have been performed using the Bruker-66 infrared spectrometer. We report results obtained for two QCL series of samples emitting at wavelengths of 4.4μm (D63) and 4.7μm (D70).

Results and Discussion

Light emission power, P, strongly depends on the magnetic field, as expected. When the magnetic field is raised beyond 10 T, pronounced oscillations of P are observed. These are due to magnetic field-induced variations of the life-time of the laser transition’s upper state. The minima on the P(B) curve are attributed to enhanced, non-radiative, inter-subband relaxation with LO-phonon emission (intersubband magneto-phonon resonance). The oscillations also demonstrate a beating effect (Fig. 1). At this time, the origin of the beatings is still unclear. This could imply an influence of additional elastic scattering mechanisms or involvement of low energy states into the phonon-assisted scattering. A detailed analysis of the P(B) and spectral data that is currently in progress, and more experimental data at magnetic fields above 30 T are necessary.

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References