Opt Quant Electron (2013) 45:127–134
DOI 10.1007/s11082-012-9610-z

Optical gain modeling of InP based InGaAs(N)/GaAsSb type-II quantum wells laser for mid-infrared emission

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Received: 14 July 2012 / Accepted: 1 August 2012 / Published online: 12 August 2012
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Abstract Optical gain performance of InP based "W" structure with InGaAs(N)/GaAsSb type-II quantum wells are investigated theoretically. The band structure was calculated by using k·p model, taking into account the conduction band mixing with N resonant band, valence band mixing, as well as strain effect. Our studies show that these type-II quantum wells are suitable for mid-infrared (2–4 µm) operation at room temperature.

Keywords Mid-wavelength infrared (MWIR) · Dilute nitride InGaAsN · GaAsSb · Type-II quantum well · Optical gain

1 Introduction

Laser diodes operating in the short- and mid-infrared wavelength domain (2–5 µm) have desirable for many applications in trace-gas analysis, pollution monitoring and molecular spectroscopy. Especially, the wavelength range from 2 to 4 µm is of great interest, due to strong absorption lines of many important industrial gases such as CO, CH_4,N_2O, and NH_3 (Rothman 2005).

Significant progress in mid wavelength infrared (MWIR) laser diodes has been reported, such as quantum cascade laser and GaSb based quantum well lasers. Unfortunately, it is difficult for quantum cascade lasers (QCLs) to obtain high performance at wavelengths shorter than around 3.5 µm due to scattering into indirect valleys (Semtsiv et al. 2008). Moreover, GaSb based quantum wells have been used in the MWIR region of lasers operating at room temperature (Belenky 2011). However, growth and processing of the GaSb based materials is less advanced than that of the InP based materials, which is commercially used for optical fiber based telecommunication applications. Furthermore, InP has higher thermal conductivity and lower electrical resistance than the quaternary compound AlGaAsSb, which shows

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