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Analysis of linewidth enhancement factor for compressively strained AlGaInAs and InGaAsP quantum well lasers

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Abstract We have compared and analyzed theoretical investigation for the possibility of extreme reductions in the linewidth enhancement factor (α-factor) in strained layer quantum-well (QW) lasers between AlGaInAs and InGaAsP material. Valence band effective masses and optical gain in both types of QW lasers under compressive strain have been calculated using 4×4 Luttinger–Kohn Hamiltonian. We have used Kramers–Kronig relations to calculate the refractive index change due to carrier induced. The α-factor was up to 1.61 times smaller in AlGaInAs QW than in InGaAsP QW laser. The material differential modal gain and carrier induced refractive index change was found to be approximately 1.38 times larger and 1.15 times smaller respectively, in the previous material QW than in the latter QW laser. We also compared our results to the previously reported results for both QWs lasers.

Keywords Quantum well · AlGaInAs · Linewidth enhancement factor

1 Introduction

The linewidth enhancement factor is a key parameter in semiconductor lasers under cw operation and under high frequency modulation (Welford and Mooradian 1982). It characterizes the linewidth broadening due to fluctuation in the carrier density altering the refractive index (Harder et al. 1983). Strained layer quantum well has been extensively investigated to improve the modulation bandwidth of semiconductor laser diodes. The improved performance of strained layer QW lasers originates from the reduced valence band mixing effects realized by increasing the energy separation between heavy hole and light hole states (Yablonovitch and Kane 1988). As a result, the density of states in the valence band is reduced and consequently a higher differential gain, smaller α-factor and reduced threshold carrier density (Okai et al.

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