P16

Optical gain spectra of GaAsBi/GaAs quantum wells in parabolically graded AlGaAs barriers calculated in semi-classical approach

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GaAsBi ternary semiconductor alloys are in the center of attention due to its potential to be used for the near-infrared spectral range optoelectronic devices including semiconductor laser diodes. Promising results were achieved in recent years developing growth technology of GaAsBi/GaAs/AlGaAs-based quantum wells (QWs) in part of successfully implemented advanced quantum structures. Indeed, the band-gap engineering paves a way for virtually unlimited number of designs when the conventional rectangular QWs are combined with parabolic QWs. However, while technology allows to grow sophisticated quantum structures in active layers for GaAsBi-based laser diodes, the theoretical description of the designs is somewhat lagging behind. The practical models can draw some guidelines in the trail and error approach usually exercised by the technology developers. First, we have adopted the semi-classical model to calculate the spontaneous intra-band recombination emission spectra among equidistant sub-bands of parabolic QWs in the conduction band [1]. We have studied the case when additional potential is introduced at the bottom of parabolic QW to see how it affects the sub-band arrangement of the parabolic potential. Later, we have extended the model to calculate the inter-band spontaneous radiation spectra. The calculated emission spectrum for GaAs/AlGaAs parabolic QW gave fairly exact solution when compared to the experimentally measured photoluminescence (PL) spectra of molecular-beam-epitaxy-grown structure designed after the model tailored growth parameters [2]. In this work, the semi-classical model is elaborated to calculate the optical gain spectra of inter-band radiative transitions of GaAsBi/GaAs QWs in parabolically graded AlGaAs barrier structures. The optical gain spectra are calculated on the basis of four GaAsBi QW samples with known growth parameters. The spontaneous radiation emission spectra are compared with the PL spectra of the GaAsBi quantum structures. The preliminary results show the calculated optical gain spectra dependence on the Bi content in the QWs in graded AlGaAs barrier designs.

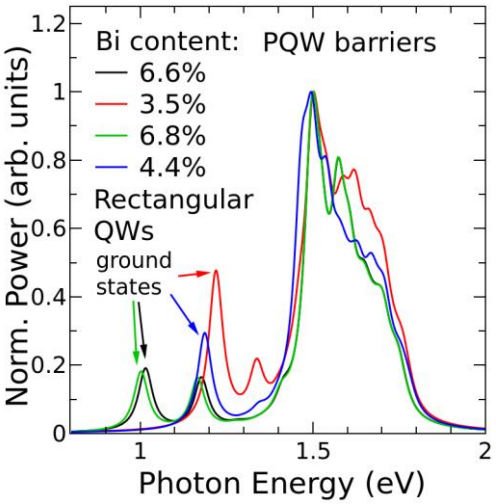

Fig. 1 Inter-band spontaneous radiation spectra calculated using semi-classical approach for four Bi contents in the QWs.

REFERENCES

[1] M. Karaliunas, A. Udal, and G. Valusis, Lith. J. Phys. 60(2), 113-124 (2020).
[2] M. Karaliunas *et al*., J. Lumin. 293, 118321 (2021).