Optical Properties of InGaAs and GaAsBi Quantum Wells with Graded AlGaAs Barriers

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In recent years, there has been significant growth in demand for new optoelectronic devices operating the near-infrared (NIR) region. The use of quantum well (QW) structures, as an active media for such emitters, has been already demonstrated and is widely used in the development of optoelectronic devices [1]. However, various technological improvements, such as an implementation of different quantum structure designs, like separate-confinement-heterostructures (SCH), are still being researched and investigated to improve the collection of carriers towards the active region [2], increase the luminescence intensity [3] and enhance the efficiency of these devices [4]. While the expected increase of emission efficiency is up to 15% for parabolically graded structure [4], our group has showed that GaAsBi/AlGaAs quantum wells with parabolically graded barriers can exhibit a boost in room temperature photoluminescence (PL) intensity by 50 times, compared to conventional rectangular QWs [3].

This study presents a further investigation on the parabolic barrier design for GaAsBi/AlGaAs as well as InGaAs/AlGaAs QWs. Moreover, optical properties of QWs with linear graded-index confinement are studied. This work determined that parabolic barrier design for GaAsBi and InGaAs quantum wells enhances PL intensity more than triangular barrier design. All in all, this comparative study concentrates on the influence of different barrier designs, specifically rectangular, parabolic (Fig. 1a) and triangular (Fig. 1b) barrier profiles, on the optical performance of QW structures using excitation, room-temperature and temperature-dependent photoluminescence spectroscopy as well as theoretically estimated carrier trapping efficiency.

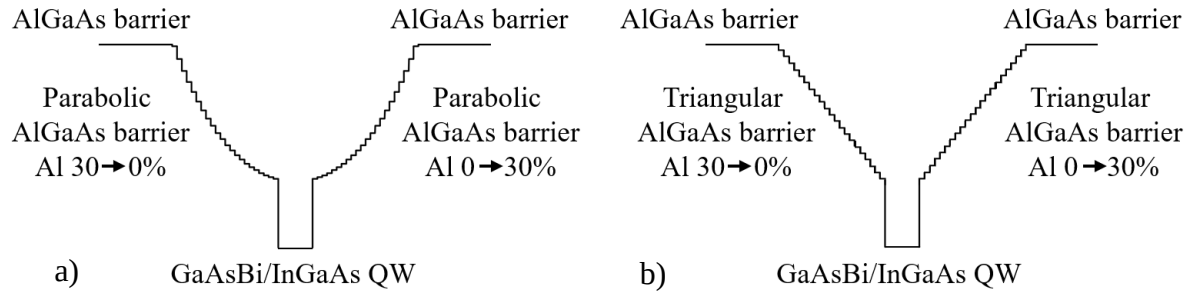

Fig. 1. Sketches of the designs of single GaAsBi/ InGaAs QW with: a) parabolic AlGaAs barriers, b) triangular AlGaAs barriers.

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