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Optical properties of as-grown and annealed GaAs/GaAsBi single quantum well structures grown by Molecular Beam Epitaxy

H Alghamdi[1], M Henini[1], D Fan[2], Y I Mazur[3], M E Ware[2], S Q Yu[2] and G J Salamo[2]
[1]University of Nottingham, UK
[2]University of Arkansas, USA

Dilute bismuth III-V alloys grown on GaAs substrates have attracted a great deal of attention due to their unusual fundamental properties. Incorporating a small amount of Bi into GaAs strongly affects the band structure of GaAs. For example, a band gap reduction of about 90 meV per percent of Bi and a large increase of spin-orbit (SO) split-off energy have been observed. GaAsBi/GaAs quantum wells (QWs) are of interest because of their potential applications in near-infrared optoelectronics devices (1.0–1.55 μm) and spintronic-related devices. The In this work, photoluminescence (PL) spectra are measured at different temperature for GaAs1-xBix /GaAs quantum wells (QWs). PL measurements were applied to study the optical properties, particularly the localized and delocalized states and carrier dynamics in GaBixAs1-x/GaAs QWs grown by Molecular Beam Epitaxy (MBE) on GaAs (001) substrates having different thicknesses ranging from 6nm to 24nm. The temperature range 10-300K was carried out. With increasing width of QW the ground state transition (i.e., the transition between the first heavy hole and the first electron subband) decrease as expected. However, the temperature dependent PL shows an S-shape behavior, which is a signature of localization effect. Room temperature photoluminescence indicate that the samples have excellent structural and optical properties. The effect of rapid thermal annealing on the optical and structural properties is investigated. In order to improve the PL spectra, thermal annealing techniques have been used in many dilutes III-V semiconductor material systems, including GaAsN. In this work, the effects of thermal annealing on GaAs1-xBix/GaAs single QWs have also been studied. For a 60 second annealing time, 500ºC and 650ºC temperature did not make any improvement in PL peak intensity. For calculation the energy levels of these samples, we used a modeling which allowed to determine the Bi composition for these samples and the calculations were consistent with the results of PL measurements. The high optical quality of samples is attributed to the surfactant of Bi through the low-temperature growth of GaAs and GaAsBi layers.

haifa.alghamdi@nottingham.ac.uk