EMISSION AND STRUCTURE VARYING AT ANNEALING MBE GaAs/AlGaAs HETEROSTRUCTURES WITH InAs QUANTUM DOTS AND STRAIN REDUCED AlGaInAs LAYER

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InAs quantum dots (QDs) embedded in MBE grown GaAs/Al0.30Ga0.70As/AlGaInAs/Al0.30Ga0.70As/GaAs quantum wells (QWs) have been investigated in as grown state and after thermal annealing at 710°C for two hours. Three types of QD structures with the different compositions of AlGaInAs capping layers and the same composition of buffer layers are compared and studied by means of photoluminescence (PL), X-ray diffraction (XRD) and high resolution HR-XRD methods. The next types of QD capping layers have been used: GaAs (#1), Al0.30Ga0.70As (#2) and Al0.10Ga0.75In0.15As (#3). XRD and HR-XRD techniques are applied with the aim to control the quality of crystal structures, as well as varying the material compositions and elastic strains in QW layers at thermal annealing. The highest PL intensity, smaller PL band half width and lower energy of ground state (GS) emission are detected in the structure with the Al0.10Ga0.75In0.15As capping layer. Thermal annealing leads to the shift of PL spectra into the higher energy range and the value of this shift is more essential in the structure with the Al0.10Ga0.75In0.15As capping layer as well. The variation of GS emission peak versus temperature has been monitored within the range of 10-450K for as grown and annealed states and it compared with temperature shrinkage of band gap in the InAs and GaAs bulk crystals. It permits to reveal that the QD composition in #3 is closer to InAs and the efficiency of Ga/In intermixing at annealing in #2 is less than in #1 and #3. Finally the reasons of PL spectrum transformation at annealing, the mechanism of PL thermal decay, and the advantages of QD structure with strain reduced Al0.10Ga0.75In0.15As capping layer have been analyzed and discussed. The composition variation of QDs and QWs at annealing has been modeled using the simulation of HR-XRD results with Xpert Expitaxy software.

Keywords: InAs QUANTUM DOTS, EMISSION, AlGaInAs strain reduced layer

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