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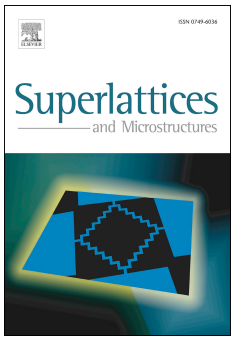

Theoretical studies on band structure and optical gain of GaInAsN/GaAs /GaAs cylindrical quantum dot

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Theoretical studies on band structure and optical gain of GaInAsN/GaAs cylindrical quantum dot

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Abstract

Electronic band structure, effective masses, band offsets and optical gain of $Ga_{0.661}In_{0.339}N_{0.0554}As_{0.9446}$/GaAs quantum dot systems are investigated using 10 band **k·p** Hamiltonian for various nitrogen and indium concentrations. The calculations include the effects of strain generated due to the lattice mismatch and the effective band gap of GaInAsN/GaAs heterostructures. The variation of conduction band, light hole and heavy hole band offsets with indium and nitrogen compositions in the alloy are obtained. The band structure of $Ga_{0.661}In_{0.339}N_{0.0554}As_{0.9446}$/GaAs quantum dot is found in the crystal directions Δ (100) and Λ (111) using 10 band **k·p** Hamiltonian. The optical gain of the cylindrical quantum dot structures as functions of surface carrier concentration and the dot radius is investigated. Our results show that the tensile strain of 1.34% generates a band gap of 0.59 eV and the compressive strain of 2.2% produces a band gap of 1.28 eV and the introduction of N atoms has no effect on the spin orbit split off band. The variation of optical gain with the dot size and the carrier concentration indicates that the optical gain increases with the decrease in the radius of the quantum dot. The results may be useful for the potential applications in optical devices.

Keywords: Quaternary semiconductor; Band anticrossing; Band offset; Lattice matched

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