InGaAs 응력완화층에 의한 InAs/GaAs 양자점 나노구조의 밴드구조 제어
Modification of Band Structures in InAs/GaAs Quantum Dot Nanostructures by InGaAs Strain Relief Layer

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Development of strain fields and change in strain-modified carrier confinement potentials in InAs/GaAs quantum dot structures, with $In_xGa_{1-x}As$ ternary strain-relief layers (SRL) capping the dots, were investigated numerically based on continuum elasticity and eight-band k·p theory. It was predicted that axial strain and radial strain within the dot are significantly relieved with increasing In concentration, x, in the SRL, which results in the reduction of the magnitude of two strain terms modifying the confinement potentials, namely hydrostatic strain and biaxial strain. Consequently, strain-induced modification of the conduction and valence band edges with the introduction of the SRL was such that the decrease in the conduction band edge is much more significant than the valence band counterpart, resulting in a substantial decrease in band gap with increasing In concentration. These predictions were supported by experimental observations elsewhere, in which significant redshifts in photoluminescence (PL) spectra with higher In concentration in SRLs were reported. It is thus suggested that incorporation of the SRL between the quantum dot and the spacer layer is an efficient way of controlling strains in quantum dot nanostructures. Further, this work demonstrates that the control of strain through the incorporation of SRL can modify the conduction band as well, which suggests a possibility of further extending strain-based band gap engineering to modification of conduction band in addition to the valence band.