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Growth and strain relaxation of GaAs/GaSb core/shell nanowires

OMID SALEHZADEH EINABAD, KAREN KAVANAGH, SIMON WATKINS, Simon Fraser University — The nanowire geometry allows the fabrication of highly mismatched heterostructures beyond the critical thicknesses known for thin films. The GaAs/GaSb structure is of particular interest due to its staggered type-II band alignment and large valence band offset. This staggered band line-up spatially confines the carriers at opposite sides of the GaAs/GaSb interface resulting in desirable excitonic properties. Also, the large band offset makes the fabrication of infrared optoelectronic devices feasible. Previous work has focussed on the growth of axial heterostructures of GaAs/GaAs using the vapor-liquid-solid (VLS) growth mechanism. In this work we demonstrate the growth of GaAs-core/GaSb-shell heterostructures using a combination of VLS and vapour solid (VS) growth. The nanowire growth was carried out by metalorganic vapor phase epitaxy (MOVPE) at 410 $^{\circ}$C. The large lattice mismatch between GaSb and GaAs (7.8%) results in GaSb island formation on the GaAs NW facets. For shell thicknesses less than 1.8 nm, the GaSb shell is coherently strained to the GaAs core. For thicker shells, equal axial and radial strain relaxation between the GaAs NWs and the GaSb islands is observed, associated with the formation of periodic misfit dislocations. The degree of strain relaxation for the same shell thickness decreases from 100% to 74 $\pm$ 3% with decreasing core diameter from 50 to 15 nm. Strain relaxation was calculated from the spot spacing of selected area diffraction patterns, Moiré fringe spacing, dislocation spacing and high resolution TEM images.

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