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Title:Characterization of low temperature InGaAs-InAlAs semiconductor photo mixers at 1.55  $\mu\text{m}$  wavelength illumination for terahertz generation and detection

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Abstract:The structural, optical, and electrical properties of undoped and Be doped lattice matched InGaAs-InAlAs multiple quantum well structures, grown by molecular beam epitaxy (MBE) at low ( $\sim 250^\circ\text{C}$ ) and normal ( $\sim 450^\circ\text{C}$ ) growth temperatures, have been investigated in detail. Double crystal x-ray diffraction studies showed that the thickness of the low temperature (LT) grown quantum well (QW) layers decrease with post growth annealing, while the normal temperature grown QW layers retain their initial thickness. This behaviour is associated with the As precipitation and is the first evidence and report of a direct observation of this phenomenon in LT InGaAs-InAlAs QWs. Room temperature photoluminescence (PL) measurements revealed signs of optical activities in the LT undoped and lower doped structures suggesting that the native defects in LT InGaAs-InAlAs are not sufficient to completely inhibit band to band recombination. Optimal combination of doping, including a modulation doped structure, and post growth annealing temperature results in materials with sub-picoseconds lifetimes ( $\sim 200$  fs) and a resistivity of  $\sim 10^7 \Omega/\text{sq}$ , which is a high value for this material. The results imply the possibility of fabricating efficient photo-mixers operating at the telecom wavelength of 1.55  $\mu\text{m}$  for THz imaging or other optoelectronic applications.

Number of references:22

Inspected controlled terms:aluminium compounds - annealing - electrical resistivity - gallium arsenide - III-V semiconductors - indium compounds - molecular beam epitaxial growth - precipitation - semiconductor epitaxial layers - semiconductor growth - semiconductor quantum wells - X-ray diffraction

Uncontrolled terms:semiconductor photomixers - wavelength illumination - electrical properties - optical properties - structural properties - lattice matched multiple quantum well structures - molecular beam epitaxy - double crystal X-ray diffraction - DCXRD - quantum well layers - post growth annealing - precipitation - photoluminescence measurements - band-band

recombination - modulation doped structure - post growth annealing temperature - subpicosecond lifetimes - photomixers - telecom wavelength - THz imaging - wavelength 1.55  $\mu\text{m}$  - temperature 293 K to 298 K - InGaAs-InAlAs

Inspec classification codes:A7865K Optical properties of II-VI and III-V semiconductors (thin films/low-dimensional structures) - A8130M Precipitation - A6170A Annealing processes - A6865 Low-dimensional structures: growth, structure and nonelectronic properties - A7360L Electrical properties of II-VI and III-V semiconductors (thin films/low-dimensional structures) - B2520D II-VI and III-V semiconductors - B2530C Semiconductor superlattices, quantum wells and related structures - B2550A Annealing processes in semiconductor technology

Numerical data indexing:wavelength 1.55E-06 m;temperature 2.93E+02 2.98E+02 K

Chemical indexing:InGaAs-InAlAs/int InAlAs/int InGaAs/int Al/int As/int Ga/int In/int InAlAs/ss InGaAs/ss Al/ss As/ss Ga/ss In/ss

Treatment:Experimental (EXP)

Discipline:Physics (A); Electrical/Electronic engineering (B)

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