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Design and performance of mid and long infrared III-V semiconductor superlattice materials PRESTON T. WEBSTER, ARVIND J. SHALINDAR, NATHANIEL A. RIORDAN, CHATURVEDI GOGINENI, HUAN LIANG, ANKUR R. SHARMA, SHANE R. JOHNSON, Arizona State University — The band structure and electron-hole wavefunction overlap of III-V semiconductor superlattice materials at the GaSb lattice constant is investigated for mid and long wavelength infrared applications. To facilitate the growth of arbitrarily thick pseudomorphic layers, only mole fractions and layer thicknesses that result in zero accumulated in-plane strain are considered. Despite this constraint, superlattices offer two additional free design parameters; one used to tune the ground state absorption cutoff (effective bandgap), with the other available for optimizing absorption (electron-hole wavefunction overlap) at the cutoff. In particular, the design criteria for optimal absorption as function of ground state energy is identified for lattice-matched GaSb/$InAs_{0.911}Sb_{0.089}$ and GaSb/$InAs_{0.932}Bi_{0.068}$ superlattices and strain-balanced InAs/GaInSb, InAs/InAsSb, and InAs/InAsBi superlattices on GaSb substrates. The absorption coefficient for each superlattice system is determined from spectroscopic ellipsometry measurements of InAs/InAsSb superlattices and the square of the wavefunction overlap. An increase in operating temperature results in a decrease in ground state transition energy with virtually no change in wavefunction overlap, indicating that the optimal absorption is independent of temperature.

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