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Growth and operation tolerances for type II superlattice-based mid-infrared lasers

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Abstract

The potential performance of Type II InAs/GaInSb superlattice-based mid-wavelength infrared lasers is examined theoretically. Band structure engineering is employed to determine the superlattice growth parameters that minimize intersubband absorption and Auger recombination losses, resulting in optimized designs that minimize threshold current densities. Calculations are performed to assess the impact of uncertainties in superlattice layer thicknesses and the temperature of laser operation on these optimized laser designs. We find that growth accuracies of ±3.5Å for InGaSb and ±0.25Å for InAs layers are required to retain optimization. Moreover, it is demonstrated that threshold current densities of optimized superlattices typically do not obey a simple T_0 characteristic temperature parameterization due to sharp structure in the intersubband absorption spectrum, whereas nano optimized structures can be described by T_0 over a wider temperature range. The microscopic calculations employ accurate K•p superlattice electronic band structures and matrix elements, and evaluations of the gain, intersubband absorption, threshold carrier densities, and radiative and Auger recombination rates to obtain threshold current densities.

Biography

Christoph Grein is a faculty member of the Physics Department at the University of Illinois at Chicago. His research interests include the study of the ideal operating properties of infrared lasers and detectors with strained-layer superlattice active regions, and the simulation of semiconductor crystal growth. He has published more than 180 papers in reputed journals.