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Title:A phonon scattering assisted injection and extraction based terahertz quantum cascade laser

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Abstract:A lasing scheme for terahertz quantum cascade lasers, based on consecutive phonon-photon-phonon emissions per module, is proposed and experimentally demonstrated. The charge transport of the proposed structure is modeled using a rate equation formalism. An optimization code based on a genetic algorithm was developed to find a four-well design in the GaAs/$Al_{0.25}Ga_{0.75}As$ material system that maximizes the product of population inversion and oscillator strength at 150 K. The fabricated devices using Au double-metal waveguides show lasing at 3.2 THz up to 138 K. The electrical characteristics display no sign of differential resistance drop at lasing threshold, which, in conjunction with the low optical power of the device, suggest-thanks to the rate equation model-a slow depopulation rate of the lower lasing state, a hypothesis confirmed by non-equilibrium Green's function calculations.

Number of references:48

Inspec controlled terms:aluminium compounds - gallium arsenide - genetic algorithms - gold - Green's function methods - III-V semiconductors - oscillator strengths - population inversion - quantum cascade lasers

Uncontrolled terms:Green function - depopulation rate - double-metal waveguides - oscillator strength - population inversion - genetic algorithm - rate equation - charge transport - phonon-photon-phonon emissions - terahertz quantum cascade laser - extraction - injection - phonon scattering - temperature 150 K - frequency 3.2 THz - GaAs-AlGaAs

Inspec classification codes:A4255P Lasing action in semiconductors - A4260B Design of specific laser systems - B4320J Semiconductor lasers - B0260 Optimisation techniques

Numerical data indexing:temperature 1.5E+02 K;frequency 3.2E+12 Hz

Treatment:Theoretical or Mathematical (THR)

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

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