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Abstract Book

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Investigation of the optimum phonon depopulation energy separation in a GaAs/AlGaAs superlattice

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Quantum cascade lasers (QCLs) emit light in the mid infrared and terahertz (THz) spectral region through unipolar intersubband transitions in bandgap engineered semiconductor heterostructures [1]. The emission spectrum allows for applications including gas sensing, free-space communication, and imaging [2].

Recent advances in THz QCLs have allowed for the operating temperature to move from cryogenic temperatures to Peltier cooling, which was achieved using the GaAs/AlGaAs material system with a three-well active region design [3]. One approach to further increase the working temperature is the optimization of the transport mechanisms that occur in the active region.

For the present study the resonant phonon depopulation process of GaAs/AlGaAs systems in the three-well active region design is investigated. Five GaAs/AlGaAs superlattice structures, which represent only the phonon depopulation part of the active region in a THz QCL, are grown using molecular beam epitaxy. For these structures the well and barrier widths are varied in a way that corresponds to different energy separations for the resonant phonon depopulation ranging from 32 to 48 meV. The grown samples are then processed in the double-metal Au-Au waveguide geometry into mesa devices. To characterize the temperature dependent transport behavior of the different samples, current voltage (I-V) curves are recorded in the temperature range of 50 K up to 300 K.

The recorded I-V curves indeed indicate a temperature dependent shift in the phonon resonance. Structures with higher phonon energy separation indicate larger temperature dependence. The latest results of this study will be presented.

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[3] M. Kainz et al., in: Optics Express 27, no. 15, pp. 20688-20693 (2019).

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