Fourier-transform temperature-resolved photoluminescence of GaSb-based resonant tunneling structures with GaInAsSb absorption layer

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Resonant tunneling structures (RTS) play an important role in a large variety of nowadays electronic and optoelectronic semiconductor devices. Besides being applied in high-speed electronic circuits and even as THz emitters, resonant tunneling is the basic underlying physical principle used in various optoelectronic devices, such as quantum cascade lasers (QCL), interband cascade lasers (ICL) and interband cascade detectors (ICD). Compared with conventional RTSs based on the GaAs or InP material system as mostly employed in QCLs, the InAs-GaSb-AlSb material system offers a broad spectrum of bandgap energies and band alignments from staggered (type-I) to broken (type-II) [1] which e.g. enables their exploitation in light emitting and detecting optoelectronic devices covering the mid-infrared spectral range [2,3]. Substantial flexibility for band gap engineering offers the ability to design and study RTSs with various band alignments, i.e. AlSb/GaSb/AlSb, AlSb/InAs/AlSb. The exact energy structure of such complex systems is often not well known, due to for example interface layer formations.

In this work, we present a comprehensive investigation of the band structure of such a complex layered system. Methods of Fourier-transform spectroscopy were employed to investigate structures based on two asymmetric hybrid AlSb/InAs type-II barriers within a GaSb matrix. In this quantum system, the AlSb layer function as common type-I barrier for electrons and holes, whereas the InAs part functions a trap for electron confinement, while enhancing the hole barrier within the valence band. We find light emission in the mid-infrared spectral range between 3 and 8 µm. Formation of quasi-bound states in the region between the InAs/GaSb interface and the AlSb barriers was confirmed, allowing for resonant tunneling of carriers across the structure [4]. Since the structure under investigation contains two asymmetric type II quantum wells, two quasi-bound states were found.

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