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Effects of asymmetric interface profile on the electronic properties of InAs/GaSb/InSb short-period superlattice structures.

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Abstract

The antimonide-based system provides great potential for photonic devices in a wide wavelength range, including the useful 3-5 µm mid-infrared atmospheric window. In combination with InAs binary, antimonides (Sb) can form type-II with broken-gap band alignment (also called type-III). These types of heterostructures are particularly relevant because of the expected suppression of non-radiative Auger recombinations in such design.

In this communication, we use a 8x8 k.p approach and the envelope-function approximation formalism to modelled the electronic structure of InAs/GaSb/InSb short-period superlattices laser diodes. The designed structure is made of N-periods (4ML- InAs /3ML-GaSb/1ML-InSb/3ML-GaSb) (SPSLs) type-II broken gap active region, where 1ML represents one monolayer (i.e.~3Å in this materials system), which are in turn surrounded by 100 Å thick AlGaAsSb barriers lattice matched to GaSb substrate. Such active zone is appropriate for emission in the 3-4µm wavelength range.

Taken into account the effect of interface anisotropy deduced from experimental observations, our results show a significant reduction in the size-quantization energy of the electron miniband, leading to a reduction in the fundamental energy gap value between 30% and 40%. These results are in good agreement with the experimental data, demonstrating the applicability of the **k.p** method to modelling InAs/GaSb/InSb short-period superlattices and the utility of interface design as a tool in the band gap engineering of SPSLs for mid-infrared applications.

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