

Interband Phonon Assisted Tunneling in InAs-GaSb Heterostructures

M.V. Kisin^a, M.A. Stroscio^b, G. Belenky^a, and S. Luryi^a

^aDepartment of Electrical and Computer Engineering, SUNY at Stony Brook, NY 11794

^bUS Army Research Office, PO Box 12211, Research Triangle Park, NC 27709

The rate of LO-phonon assisted interband transitions in an InAs/GaSb double quantum well heterostructure is compared with the elastic interband tunneling rate through the heterostructure “leaky window”. We show that the phonon-assisted process can dominate the elastic tunneling if the anticrossing gap between the initial and final electron states participating in phonon emission is smaller than the LO-phonon energy.

The process of interband tunneling in type-II staggered-gap heterostructures is of vital importance for novel intersubband cascade lasers, where it determines the depopulation of the lower lasing states. In this work we compare the rate of elastic interband tunneling, Γ_{tun} , with the rate of the LO-phonon assisted process, Γ_{ph} ; see Figure. Initial and final electron states involved in the phonon-emission process belong, correspondingly, to the lowest electron-like and the highest light-hole-like subbands located in the upper part of the heterostructure leaky window. Under the anticrossing condition, these states are equally distributed between InAs and GaSb quantum wells thus providing for an efficient overlap with the LO-phonon potential. The electron energy spectrum of the heterostructure is analyzed in the framework of an 8-band Kane model [1]. We show

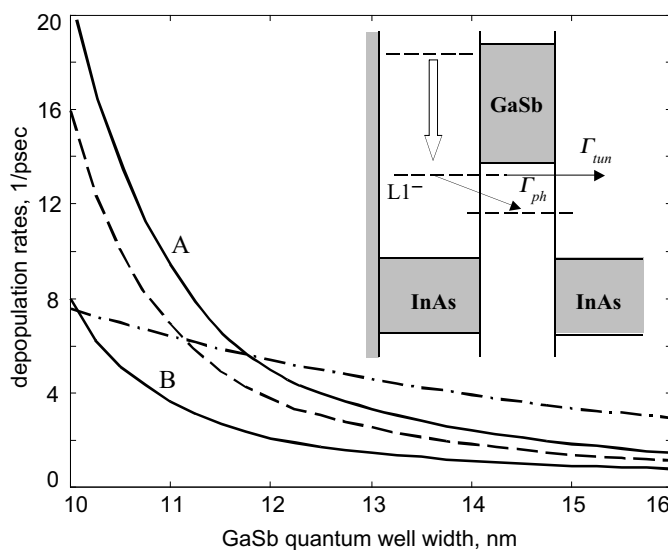
anticrossing gap the LO-phonon phonon nearly-resonant high rate. Upper and in Figure show rate for bulk-GaSb LO-respectively. shows the rate due to confined in the InAs and well layers. As

earlier [2], these modes are of primary importance when the initial and final electron states anticross. Though the highest possible rates are characteristic for only small fraction of initial and final electron states with small in-plane wave vectors, the typical overall rates represented in Figure demonstrate high efficiency of the LO-phonon assisted interband transitions which, at resonance, exceed the rate of the direct elastic interband tunneling shown in Figure by dashed-dotted line.

This work was supported by US Army Research Office.

[1] M.V. Kisin, M.A. Stroscio, S. Luryi, G. Belenky, *Physica E* (2001), in print.

[2] M.A. Stroscio, M.V. Kisin, G. Belenky, S. Luryi, *Appl. Phys. Lett.*, **75**, 3258 (1999).



that the is very close to energy, thus the emission is process with a characteristic lower solid lines the emission like InAs and phonons, The dashed line depopulation emission of the phonon modes GaSb quantum we have shown