

Spin Filtering in Asymmetric Resonant Interband Tunneling Diodes

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Recent theoretical studies suggest the possibility of polarizing electron spins by resonant tunneling [1,2], and obtaining spin-polarized current in resonant tunneling heterostructures [2]. This mechanism offers the possibility of spin filtering without magnetic fields and using only conventional non-magnetic III-V semiconductor heterostructures. A typical resonant tunneling spin-filtering device structure consists of double barriers surrounding an asymmetric quantum well, where quantized states are spin-split by the Rashba effect [3]. In this work we report our theoretical analysis of spin polarization effects in InAs/GaSb/AlSb resonant tunneling structures. We discuss the basic principles of the Rashba effect resonant tunneling spin filter, point out the challenges, and offer strategies for overcoming these difficulties. In particular, we present modeling results that demonstrate the advantages of using the InAs/GaSb/AlSb-based asymmetric resonant interband tunneling diode (a-RITD). In the RITD, conduction band electrons resonantly tunnel through quantized valence subbands. This allows the a-RITD to effectively exclude tunneling through states near the Brillouin zone center, where Rashba spin splitting vanishes and spin selectivity is difficult. Away from the zone center, spin-orbit interaction in the valence band can provide strong spin selectivity via spin-dependent tunneling. When coupled with an emitter capable of momentum space selectivity, provided by, for example, a lateral electric field, the a-RITD can achieve spin filtering. We will present spin-dependent current densities calculations, and discuss possible implementations of the a-RITD spin filter.

[1] E. A. de Andrada e Silva and G. C. La Rocca, *Phys. Rev. B*, 59, 15583 (1999).

[2] A. Voskoboynikov, S. S. Lin, C. P. Lee, and O. Tretyak, *J. Appl. Phys.* 87, 387 (2000).

[3] Y. A. Bychkov and E. I. Rashba, *JETP Lett.*, 39, 78 (1984).

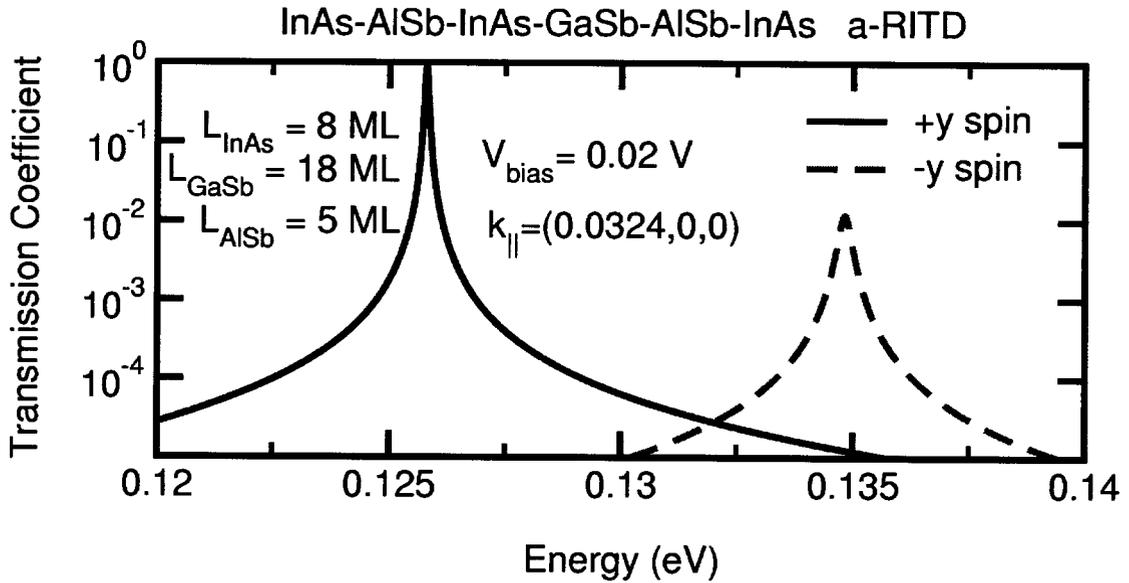


Figure 1. Spin-dependent transmission coefficient spectra for an InAs-AISb-GaSb-InAs-AISb-InAs asymmetric resonant interband tunneling diode (a-RITD). The growth axis is along z , k_{\parallel} is along x , and spin axis is along y . The $+y$ spin transmission peak is almost two orders of magnitude stronger than the $-y$ spin peak.

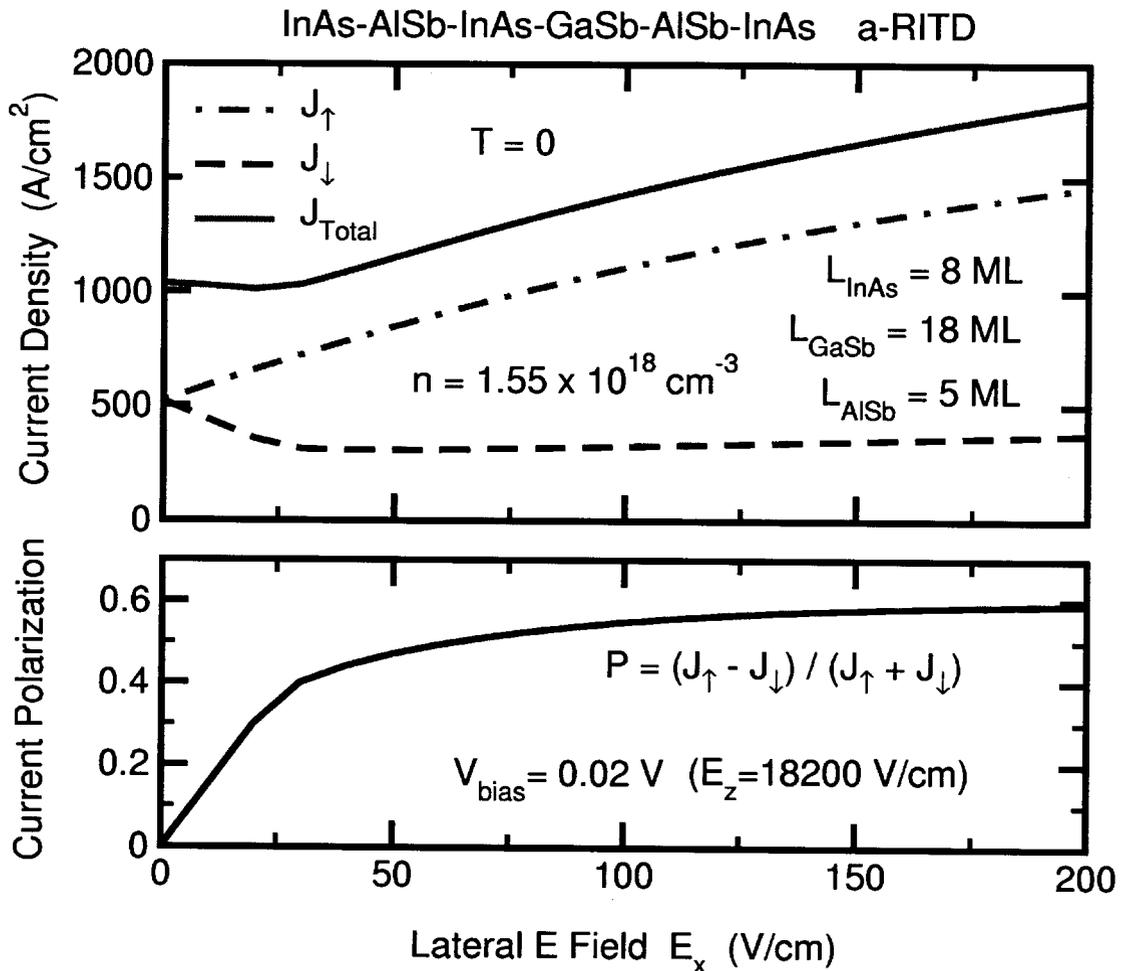


Figure 2. Spin-dependent current densities and current polarization for the a-RITD as functions of applied lateral E field.