Modeling Spin-Dependent Transport in InAs/GaSb/AlSb Resonant Tunneling Structures

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Recent theoretical studies suggest the possibility of polarizing electron spins by resonant tunneling [1], and obtaining spin-polarized current in resonant tunneling heterostructures at zero magnetic field [2]. 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. In this work we report our theoretical analysis of spin polarization effects in InAs/GaSb/AlSb resonant tunneling structures. Heterostructures of InAs/GaSb/AlSb are strong candidates for pronounced Rashba spin splittings because of the large spin-orbit interaction in InAs and GaSb, the availability of both InAs and GaSb for the construction of highly asymmetric quantum wells, and the presence of a variety (type-I, type-II staggered, and type-II broken-gap) of interface types. Our calculations show that it is possible to obtain rather large Rashba spin splittings in AlSb/InAs/GaSb superlattices even in the absence of a transverse electric field. Furthermore, the non-common anion InAs/GaSb and InAs/AlSb heterointerfaces offer opportunities for engineering interface potentials for optimizing Rashba spin splitting. The presence of the type-II broken-gap band offset also allows us to fabricate resonant interband tunnel (RIT) structures, where the quasibound states have opposite k-parallel dispersions to those in the electrodes. We will report on studies of spin-dependent tunneling in both the intraband and the interband resonant tunneling structures.

[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).