Hybrid Structures and Spin-Dependent Functionality in 6.1 A Materials

Semiconductor spintronic devices offer new functionality and performance, and span a broad range of materials and operational concepts. *Hybrid device circuits* typically incorporate a magnetic element to achieve the critical advantage of nonvolatile behavior. We illustrate that approach by a new hybrid circuit which combines resonant interband tunneling diodes (RITDs) based on 6.1 Å materials with giant magneto-resistance (GMR) elements, in which the GMR element controls the switching current and stable operating voltage points of the hybrid circuit [1]. Parallel and series combinations demonstrate continuous or 2-state tunability of the subsequent RITD-like current-voltage characteristic via the magnetic field response of the GMR element. Monostable-bistable transition logic element operation is demonstrated with a GMR/RITD circuit in both the DC limit and clocked operation. The output of such hybrid circuits is nonvolatile, reprogrammable, and multi-valued. *Spin-polarized carrier transport within a semiconductor host* offers entirely new and exciting directions for device functionality, enabled by the long spin lifetimes of electrons. We have demonstrated electrical injection of spin-polarized electrons with double digit efficiency from both a semiconducting and a metallic surface contact. Incorporating layers which enable selection or manipulation of spin within a heterostructure tremendously enhances device opportunities. To that end, we consider resonant interband tunneling diodes based on InAs/AlSb/GaMnSb, in which electrons are selectively polarized via tunneling through valence band states of the p-type ferromagnetic semiconductor GaMnSb. Material considerations and results of model calculations [2] will be discussed.

[1] A. T. Hanbicki, R. Magno, S.-F. Cheng, Y.D. Park, A.S. Bracker and B.T. Jonker, *Appl. Phys. Lett.* 79, xxx (20 August 2001).

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