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Nonmagnetic Resonant Tunneling Spin Filter and Bi-Directional Spin Pump

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We report device concepts for creating spin polarized current sources without external magnetic fields, using nonmagnetic semiconductor resonant tunneling structures. These devices contain asymmetric quantum wells where quantized states are spin-split by the Rashba effect, and achieve spin filtering by exploiting the phenomenon that the spin of a resonantly transmitted electron aligns with that of the quasibound state traversed. The resonant interband tunneling spin filter [1] exploits large valence band spin-orbit interaction to provide strong spin-dependent tunneling without suffering from fast hole spin relaxation. Its efficiency is further enhanced by the reduction of tunneling through quasibound states near the zone center, where the Rashba spin splitting vanishes. The bi-directional spin pump induces the simultaneous flow of oppositely spin-polarized current components in opposite directions through spin-dependent resonant tunneling. It can generate significant levels of spin current with very little net electrical current across the tunnel structure. We also report on BIA (bulk inversion asymmetry) enhancement of spin-filtering efficiency.

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