Rashba Effect in Type II Resonant Tunneling Diodes
Enhanced by In-plane Magnetic Fields

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Abstract

A huge Rashba splitting enhanced by an in-plane magnetic field is observed in non-magnetic InGaAs resonant tunneling diodes with GaAsSb barriers. At T=4K, the current resonances split by the Rashba effect reveal peak to valley ratios up to 2.5:1 and the energy spacing between the split peaks reaches 30 meV at B=5T. The observed peak splitting can be observed at temperatures up to T=180K and higher. The Rashba parameters determined on four different samples are between $\alpha=0.38$ eVÅ and $\alpha=0.78$ eVÅ, which are consistent with theoretical values reported for InAs quantum wells under external electric fields.

A modified Transfer Matrix Method is used to show that, in transverse magnetic fields, the $k_\parallel$ distribution of tunneling electrons is shifted to higher values. Through this process, a significant asymmetry is induced into the tunneling structure, which finally leads to a strong enhancement of the Rashba effect. Further, we find that the Rashba effect is extremely sensitive to the electric fields produced by the band discontinuities at the heterostructure interfaces and the spin-orbit coupling constants in the respective materials. Using a one-band model for the spin-orbit coupling constant, the effects of temperature and local electric fields on the Rashba parameter are also investigated. From our findings we conclude, that spin splitting effects and large spin-orbit interactions should be quite dominant on any narrow gap type-II heterostructure, and not only on the GaAsSb/InGaAs material system.

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