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A kinetic equation approach to the spin Hall effect in p-type bulk semiconductors S. Y. LIU, Stevens Institute of Technology and Shanghai Jiaotong University, China, NORMAN J. M. HORING, Stevens Institute of Technology, X. L. LEI, Shanghai Jiaotong University, China, V. FESSATIDIS, Fordham University
— A two-band kinetic equation method is employed here to investigate the spin-Hall effect (SHE) in a p-type Luttinger semiconductor. We find that the previously predicted solely intrinsic SHE arises from a dc-field induced polarization directly, or in other words, a stationary Rabi process, associated with all hole states below the Fermi surface. The total SHE, encompassing a mix of both extrinsic and intrinsic features, results essentially from a related polarization process involving electric field excitations between heavy- and light-hole bands, both directly and indirectly through scattering. In particular, we examine effects of long-range disorder on spin-Hall current (SHC) within the self-consistent Born approximation. In contrast to the vanishing SHC contribution due to short-range disorder, we show that long-range impurity scattering produces a nonvanishing SHC, independent of impurity density, having its sign opposite to that of the intrinsic SHC contribution and leading to a significant reduction of the total SHC. This disorder-generated SHE arises from a disorder-mediated interband polarization, related only to hole states near the Fermi surface. We analyze the hole density dependencies of SHC and spin mobility numerically: with increasing hole density, the SHC first increases and then decreases, while the spin mobility decreases monotonically.

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