Spin Hall effect in disordered organic solids

ZHI-GANG YU, Applied Sciences Laboratory, Washington State University — We study the spin Hall effect (SHE) in disordered π-conjugated organic solids, where individual molecules are oriented randomly and electrical conduction is via carrier hopping. The SHE, which arises from interference between direct \((i \rightarrow j)\) and indirect \((i \rightarrow k \rightarrow j)\) hoppings in a triad consisting of three molecules \(i, j\) and \(k\), is found to be proportional to \(\lambda(n_i \times n_j + n_j \times n_k + n_k \times n_i)\), where \(\lambda\) is the spin admixture of π electrons due to the spin-orbit coupling and \(n_i\) is the orientation vector of molecule \(i\). Electrical conductivity \(\sigma_{qq} (q=x,y,z)\) and spin-Hall conductivity \(\sigma_{sh}\) are computed by numerically solving the master equations of a system containing \(32 \times 32 \times 32\) molecules and summing over contributions from all triads in the system. The obtained value of spin Hall angle, \(\Theta_{sh} \equiv \sigma_{sh}/\sigma_{qq}\), is consistent with experimental data in PEDOT:PSS, with a predicted temperature dependence as \(\log \Theta_{sh} \sim T^{-1/4}\).

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