Topological insulators and their spintronics applications

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It is envisioned in ideal spintronics that information storage, transmission and processing are carried out using pure spin current and spin accumulation, which are controlled with electric field or voltage. Charge current is avoided in these processes so that they are (almost) dissipationless. Such dissipationless spin current and accumulation may be realized with quantum spin Hall effect (QSHE) in topological insulators which are some narrow-gap semiconductors with unique electronic band structures due to their lattice structure and a strong spin-orbital coupling (SOC). In these topological insulators, there are robust Kramers pairs of boundary states which are in the bulk bandgap and move in opposite directions for opposite spins. HgTe quantum well, Bi atomic layers, $Bi_{1-x}Sb_x$ alloy, Bi_2Se_3 and Sb_2Te_3 are among such topological insulator materials.

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