Spin-Polarization Control at the Surface of a Topological Insulator

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Topological insulators, with a gapless topological surface state (TSS) located in a large bulk bandgap, define a new quantum phase of matter. Their uniqueness, and their strong application potential in quantum electronic devices, stem from the TSS combination of spin polarization and protection from backscattering. Unfortunately the exploitation of these properties has so far been hampered by the intrinsic instability of the materials' surfaces. Here we show, as revealed by ARPES for the case of Bi_2Se_3, that the surface electronic properties can be stabilized and controlled by the deposition of potassium in ultra-high vacuum conditions. In addition to accurately setting the carrier concentration, new Rashba-like states with strong spin polarization can be induced by in-situ K deposition; the size of the spin splitting in these new states can be tuned as desired, and reversibly. We also demonstrate that the surfaces prepared this way, and the induced new spin-polarized states, are robust against contamination and can survive at room temperature in vacuum. These results are crucial for understanding the novel physical phenomena of topological insulators and pave the way to controlled approaches for developing room temperature spintronic devices.

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