Topological confined massive surface states in strained bulk HgTe probed by RF compressibility

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Abstract

It is well established that topological insulators sustain Dirac fermion surface states as a consequence of band inversion in the bulk. These states have a helical spin polarization and a linear dispersion with large Fermi velocity. In this talk we will report on a set of experimental observations indicating the existence of massive surface states. These states are confined at the interface and dominate equilibrium and transport properties at high energy and/or high electric field. By monitoring the AC admittance of HgTe topological insulator field-effect capacitors, we access the compressibility and conductivity of surface states in a broad range of energy and electric fields. The Dirac surface states are characterized by a compressibility minimum, a linear energy dependence and a high mobility persisting up to energies much larger than the transport bandgap of the bulk. New features are revealed at high energies with signatures such as conductance peaks, compressibility bumps, a strong charge metastability and a Hall resistance anomaly. These features point to the existence of excited massive surface states, responsible for a strong intersubband scattering with the Dirac states and the nucleation of metastable bulk carriers. The spectrum of excited states agrees with predictions of a phenomenological model of the topological-trivial semiconductor interface. The model accounts for the finite interface depth and the effect of electric fields. The existence of excited topological states is essential for the understanding of topological phases and opens a route for engineering and exploiting topological resources in quantum technology.

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