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Two-dimensional topological insulators enable the fabrication of field-effect transistors with imperfect materials[1] WILLIAM VANDENBERGHE, MASSIMO FISCHETTI, University of Texas at Dallas — Many new two-dimensional materials such as transition-metal dichalcogenides are being researched for nanoscale field-effect transistor (FET) applications. Unfortunately, these new materials often suffer from a large concentration of defects, such as line-edge roughness, that are inevitable in the fabrication process of nanoscale devices and that degrade the performance of conventional FETs . We show how transistors made of two-dimensional topological insulator (2D TI) ribbons can operate in the presence of a large number of imperfections. In the on-state, the current flows in the topologically protected edge states and charge carriers are subject to minimal back-scattering due to imperfections. In the off-state, the current flows in bulk states in which carriers suffer from severe back-scattering due to imperfections. We obtain quantitative results for the FET performance by solving the Boltzmann equation self-consistently with the Poisson equation for different levels scattering with imperfections. We show that the 2D TI FETs exhibit a high-performance and low power consumption and therefore competitive with conventional and other proposed FET designs.

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