# The Topological Transistor as a Low-Voltage Switch

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The impending end of Moore’s Law has prompted a search for a new computing technology with vastly lower energy consumed per operation than silicon CMOS. The recent discovery of topological phases of matter offers a possible solution: a “topological transistor” in which an electric field tunes a material from a conventional insulator “off” state to a topological insulator “on” state, in which topologically protected edge modes carry dissipationless current. This electric field-tuned topological transition has advantages over current MOSFETs: (1) Due to the combined effects of Rashba spin-orbit interaction and electric field control of the bandgap, the topological transistor may switch at lower voltage, overcoming “Boltzmann’s tyranny”[1], and (2) true electric field-controlled switching opens the possibility of using the full power of negative capacitance structures as an electric field amplifier to achieve further reductions in switching voltage[2] (see Fig. 1). We have studied thin films of Na3Bi grown in ultra-high vacuum by molecular beam epitaxy as a platform for topological electronic devices. When thinned to a few atomic layers Na3Bi is a large gap (>300 meV) 2D topological insulator, and electrical transport measurements demonstrate that the current is carried by helical topological edge modes over millimeter-scale distances[3]. Electric field applied by proximity of an STM tip can close the bandgap completely and reopen it as a conventional insulator[4] (see Fig. 2) demonstrating the basis of electric field-switched topology.

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