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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: 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", and 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. 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. Electric field applied by proximity of an STM tip can close the bandgap completely and reopen it as a conventional insulator demonstrating the basis of electric field-switched topology.

Sala de conferencias – Edificio I+D+i (Campus Río Ebro)

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