Voltage-Driven Magnetization Control In Topological Insulator/Magnetic Insulator Heterostructures

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A major barrier to the development of spin-based electronics is the transition from current-based (via spin transfer torque or the spin Hall effect), or magnetic-field-based magnetization reversal, to a more scalable voltage-based magnetization reversal. To achieve this, multiferroic materials appear attractive, however the effects in current materials often occur at very large voltages or at low temperatures. Here the potential of a new class of hybrid multiferroic materials is described, consisting of a topological insulator adjacent to a magnetic insulator. As these materials lack conducting states at the chemical potential in their bulk, no dissipative charge currents would flow in the bulk in response to the applied voltage. Surface states at the interface between the topological insulator and the magnetic insulator, if present (i.e. if the magnetic insulator is topologically trivial) act similar to surface recombination currents in bipolar devices, but can be passivated using magnetic doping. The dependence of the switching power on device geometry and material parameters is presented, and is exceptionally low, suggesting that such hybrid multiferroics could form the basis of a new architecture for spin-based memory and logic. The role of surface-passivating topological insulator materials, which would play a similar role to the presence of a barrier for electronic states in quantum wells, is also described. These general considerations on the role of topological insulators in a voltage-driven spintronic architecture should assist in the design of functional, e cient heterostructures relying on voltage-driven magnetization dynamics.

BIO: Michael E. Flatté is an expert in condensed matter and materials theory, specializing in carrier and spin dynamics and their applications to novel semiconductor devices. His research foci include semiconductor spintronics, solid-state quantum computation, carrier dynamics in semiconductor nanostructures, and nanoparticle dynamics in heterogeneous liquids. He has over 135 publications as well as 12 review articles/book chapters, 4 patents, and one edited book.

Michael E. Flatté received the A.B. in Physics from Harvard and the Ph.D. in Physics from the University of California Santa Barbara, advised by Walter Kohn. After a postdoctoral year at the Institute for Theoretical Physics at UC Santa Barbara and a postdoctoral fellowship at Harvard University's Division of Applied Sciences he joined the faculty at The University of Iowa in 1995. Michael E. Flatté is a Fellow of the American Physical Society and the American Association for the Advancement of Science and is the F. Wendell Miller Professor of Physics at The University of Iowa.