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Local optical control of ferromagnetism and chemical potential in a topological insulator[1]

ANDREW L. YEATS[2], Institute for Molecular Engineering, University of Chicago

The symmetry-protected surface and edge states of topological insulators (TIs) are attractive for applications in spintronics and quantum computing. Many proposed experiments involving TI materials require spatial control over time-reversal symmetry and chemical potential. We demonstrate rewritable micron-scale optical control of both magnetization and chemical potential in ferromagnetic thin films of Cr-$(Bi,Sb)_2Te_3$ grown on $SrTiO_3$ [1]. By optically modulating the coercivity of the films, we write and erase arbitrary patterns in their remnant magnetization, which we then image with Kerr microscopy. Additionally, by optically manipulating a space charge layer in the underlying $SrTiO_3$ substrates, we control the local chemical potential of the films. This optical gating effect allows us to write and erase p-n junctions in the films, which we study with photocurrent microscopy [2]. Both effects persist for $>$ 16 hours and may be applied simultaneously. We will present systematic Kerr microscopy, photocurrent microscopy, and electrical transport studies of these materials, as well as various electronic and magnetic structures patterned on them. We will discuss the prospects for using these optical phenomena to study and control the unique physics of TIs, such as 1D edge-state transport in the quantum anomalous Hall regime.

[1] A. L. Yeats, P. J. Mintun, Y. Pan, A. Richardella, N. Samarth, D. D. Awschalom, in prep., (2016).
[2] A. L. Yeats, Y. Pan, A. Richardella, P. J. Mintun, N. Samarth, D. D. Awschalom, Science Advances 1, e1500640 (2015).

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