The Pennsylvania State University, N-338 Millennium Science Complex, University Park, PA 16802

MIP: 2DCC at Penn State University, DMR-1539916
2017

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

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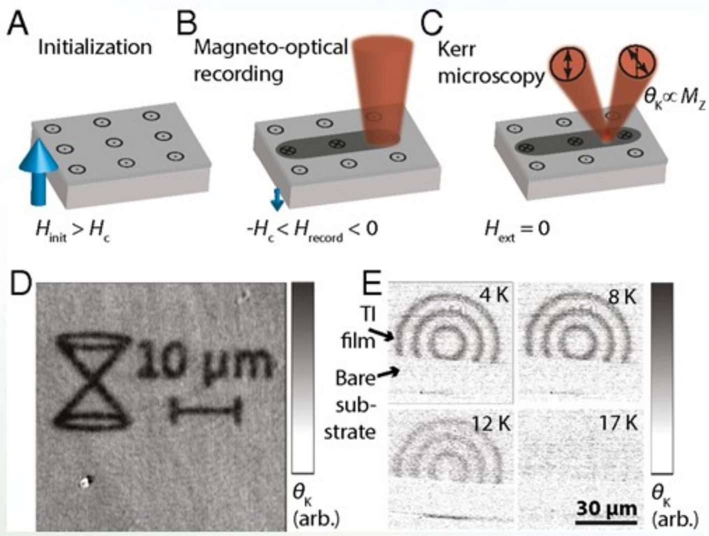
Ferromagnetic topological insulators (TIs) have promise for applications in spintronics, metrology, and quantum computing. However, TI materials are fragile and often incompatible with nanofabrication techniques. We have developed a technique that enables persistent, micron-scale optical control of both magnetization and chemical potential in Cr-$(Bi,Sb)_2Te_3$ grown by MBE on $SrTiO_3$. This system is uniquely positioned to enable arbitrary routing of the quantized edge states recently discovered in magnetic TIs. We also use Kerr and photocurrent microscopies to image magnetic inversion dynamics, p-n junctions, and magnetic recordings that we make in these materials. This work may enable dynamic, reconfigurable control of 1D quantum channels.



Also supported by: NSF DMR-1306300, NSF DMR-1306510, NSF DMR-1420709, ONR-N00014-15-1-2369, ONR-N00014-15-1-2370, AFOSR FA9550-14-1-0231, and DE-AC02-06CH11357

NSF DMR DIVISION OF MATERIALS RESEARCH
DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Figure Title: Local Optical Control of Ferromagenetism and chemical potential in a topological insulator.

Figure Caption: Magneto-optical recording. (A–C) Protocol for magneto-optical recording in a magnetic TI. (A) A strong magnetic field (1,000 Gauss) is used to uniformly magnetize the film. (B) Laser illumination (32 μW) locally reduces the coercivity of the film, allowing its magnetization to be inverted by a weak opposing field (−63 Gauss). (C) The pattern remains persistent at zero field and can be measured with scanning Kerr microscopy at low power (4 μW). (D) Scanning Kerr micrograph of magnetization pattern recorded in a thin film of Cr-(Bi,Sb)2Te3. (E) Magneto-optical recording as a function of temperature. No effect is seen above TC or from the substrate in areas where the magnetic film has been scratched away.

What Has Been Achieved: Ferromagnetic topological insulators (TIs) have promise for applications in spintronics, metrology, and quantum computing. However, TI materials are fragile and often incompatible with nanofabrication techniques. We have developed a technique that enables persistent, micron-scale optical control of both magnetization and chemical potential in Cr-(Bi,Sb)2Te3 grown by MBE on SrTiO3. This system is uniquely positioned to enable arbitrary routing of the quantized edge states recently discovered in magnetic TIs. We also use Kerr and photocurrent microscopies to image magnetic inversion dynamics, p-n junctions, and magnetic recordings that we make in these materials.

Importance of Achievement: This work may enable dynamic, reconfigurable control of 1D quantum channels in magnetically doped topological insulators.

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Unique Features of the MIP That Enabled Project: MBE growth of high quality magnetically doped topological thin films on SrTiO3 substrates.

Publication: Yeats, A.L., Mintun, P.J., Pan, Y., Richardella, A., Buckley, B.B, Samarth, N. and Awschalom, D.D. (2017) Local optical control of ferromagnetism and chemical potential in a topological insulator. Proceedings of the National Academy of Sciences. DOI: 10.1073/pnas.1713458114.

The 2DCC-MIP is funded by NSF cooperative agreement DMR-1539916.