FA07

Controlling Magnetism by Light

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Recently, we have observed ultrafast and nonthermal effects of light on magnetization. It was shown that a fs circularly polarized laser pulse acts on spins as a similarly short magnetic field pulse with strengths up to 1 T. Moreover, excitation by right- and left-handed circularly polarized pulses corresponds to magnetic fields of opposite polarity. Therefore, in contrast to the well- known magneto-optical Faraday effect, where the polarization of light is affected by magnetic order, these experiments demonstrate the feasibility of the inverse, opto-magnetic phenomenon: polarized light affects magnetic order via the inverse Faraday effect. Such laser-generated magnetic field is a fundamentally novel stimulus of magnetism providing unprecedented means for excitation and coherent control of spins on a subpicosecond timescale.

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FB01

Extraordinary Magnetoresistance Effects and Local Control of Magnetocrystalline Anisotropy in (Ga,Mn)As Devices

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The family of (III,Mn)V ferromagnetic semiconductors offers unique opportunities for exploring the integration of two frontier areas in information technology: spintronics and nano-electronics.

In my talk I will address two novel phenomena recently observed in micro- and nano-structures patterned from this ferromagnetic material with strong spin-orbit coupling, the Coulomb blockade Anisotropic Magnetoresistance (CBAMR) [1] effect and lithographically controlled magnetocrystalline anisotropy applied for current induced domain wall propagation [2].

I will first address the CBAMR effect in a (Ga, Mn)As single electron transistor. We found low-field hysteretic magnetoresistance which can exceed 3 orders of magnitude. The sign and size of the magnetoresistance signal are controlled by the gate voltage.

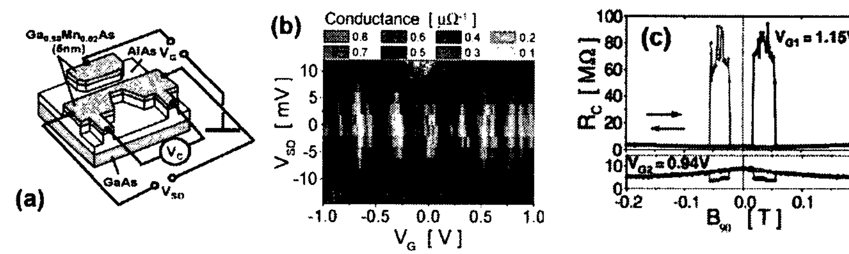

Fig. 1. (a) Schematics of our ferromagnetic SET. Trench isolated side-gate and channel aligned along the [110] direction were patterned by e-beam-lithography and reactive ion etching in a 5 nm ($Ga_{0.98}$, $Mn_{0.02}$) As epilayer. (b) CB conductance (I/V_C) oscillations with gate voltage for different source-drain bias. The diamond patterns in this 2D plot are clear fingerprints of single-electron transport.

The CBAMR is interpreted in terms of electrochemical shifts associated with magnetization rotations. Effective kinetic-exchange model calculations in (Ga,Mn)As show chemical potential anisotropies consistent with experiment and ab-initio calculations in transition metal systems suggest that this generic effect persists to high temperatures in metal ferromagnets with strong spin-orbit coupling.

In the second part I will present recent experiments and theoretical modeling for lithographically engineered crystalline anisotropy in (Ga,Mn)As microdevices. The utility of locally controlled magnetic anisotropies is demonstrated in current induced switching experiments. We observed current induced magnetization switchings by domain wall propagation well below the Curie temperature at critical current densities ~10^5 A/cm^2.

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