

Triangular Diode Acts as Asymmetric Energy Barrier to Magnetic Domain Wall Movement

Control of domain wall propagation in magnetic nanostructures is vital to both the understanding of domain wall properties such as wall resistance along with the science required for applications such as novel domain wall logic devices. In the October 4 issue of *Applied Physics Letters* (p. 2848), D.A. Allwood and co-workers from the University of Durham, UK, have reported the synthesis and characterization of a lithographically-patterned magnetic structure that allows control of wall propagation along a single direction. A domain wall diode is constructed by joining planar nanowires (fabricated by focused ion-beam milling of a 3 nm thick thermally evaporated $\text{Ni}_{80}\text{Fe}_{20}$ permalloy thin film on silicon) with a structure in the form of an isosceles right-angle triangle having a 500-nm base length. Each nanowire is 9 μm in length; one 200-nm width wire is joined at the apex of the triangle along with a 100-nm width wire at the base.

Three different magnetic structures were created containing this diode. Structure I has no additional components, Structure II has a 3 $\mu\text{m} \times 600$ nm "domain wall injection pad" connected to the 200-nm width wire, and Structure III has a 3 $\mu\text{m} \times 600$ nm pad connected to the 100-nm width wire. Analysis on these structures was performed using a high-sensitivity magneto-optical Kerr effect (MOKE) magnetometer with a 27 Hz alternating magnetic field applied along the wire long axis and a 5 μm diameter laser interrogation spot. Hysteresis loops were measured for each structure (Figure 1). For Structure I, nucleation and propagation of a wall is manifested as a sharp transition. However, single 200 nm wires exhibited transitions at the same value of coercivity, indicating that these domain walls may originate in the wire ends of the structure. For Structure II, a wall is injected from the pad into the 200-nm width wire. The geometry of the diode requires the width of the propagating wall to increase, causing minimal pinning before propagation to the 100-nm width wire occurs. For Structure III, a wall is injected into the 100-nm width wire, but is unable to de-pin from this section through to the diode (reversal in the 200-nm width wire is due to nucleation). Calculations of the pinning field suggest the triangular diode can be seen as an asymmetric energy barrier to wall propagation. Overall, said the researchers, these measurements demonstrate that wall propagation occurs in one direction. Hence this is

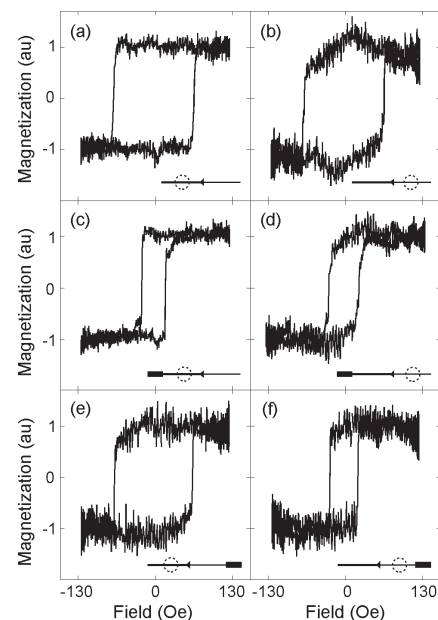


Figure 1. Hysteresis loops measured by magneto-optical Kerr effect for Structure I (a) with the laser beam on the 200 nm wire and (b) with the laser beam on the 100 nm wire; Structure II (c) 200 nm wire and (d) 100 nm wire; and Structure III (e) 200 nm wire and (f) 100 nm wire. Also inset to each plot is a schematic of the relevant structure and MOKE measurement position, indicated by the broken circle. Reprinted with permission from *Applied Physics Letters* **85** (October 4, 2004). © 2004 AIP.

truly a domain wall diode that can be utilized in memory applications requiring intrinsically defined directions of wall propagation, they said.

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New Photochromic Bands Observed in Functionalized Semiconducting SWNTs

Nanosensors are one of the many potential applications for single-walled carbon nanotubes (SWNTs). Previously, it was shown that SWNTs can function as sensors by using chemical doping, high-pressure reforming, or adsorption of atoms or functional groups to modify their electronic properties. Recently, R.F. Khairutdinov of the University of Alaska in Fairbanks and M.E. Itkis and R.C. Haddon of the University of California in Riverside have demonstrated that light can be used as a simple and convenient tool to control the electronic characteristics and, thereby, the conductivity of SWNTs.

As reported in the August issue of *Nano Letters* (p. 1529), the research team