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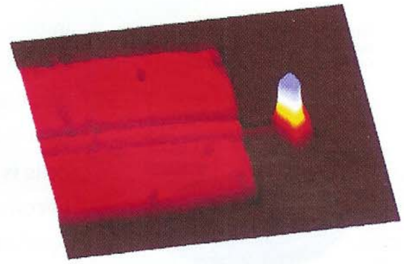

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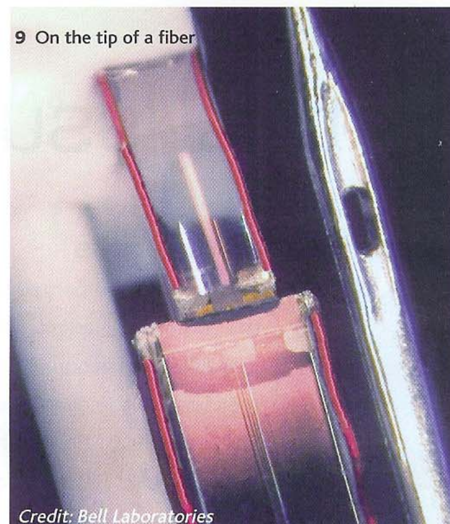
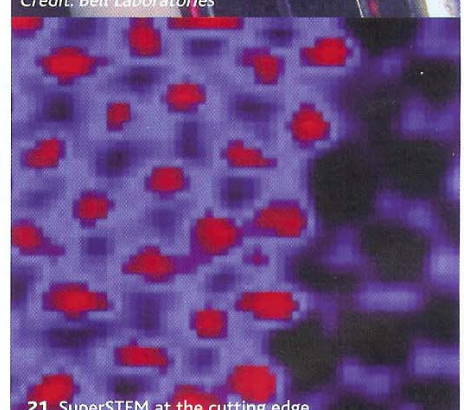


Credit: Bell Laboratories



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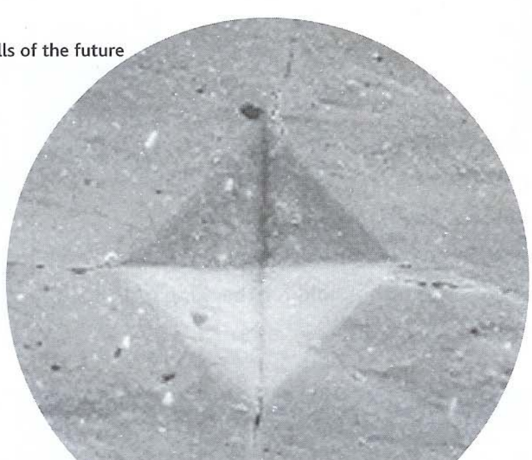


Switching memories

MAGNETIC MATERIALS

Researchers from the Centre National de la Recherche Scientifique (CNRS) in Paris, France, Instituto de Engenharia de Sistemas e Computadores in Lisbon, Portugal, and Universität Kaiserslautern, Germany have probed the limits of magnetic switches [*Phys. Rev. Lett.* (2003) 017201 and 017204].

Magnetic switches promise a highly efficient means of storing data, with the advantage of not requiring a constant power supply. The orientation of the magnetization 'flips' in direction under the influence of an external magnetic field by a process called precessional motion. Using precession to switch magnetization could yield a process that is potentially highly efficient and ultrafast.

In the first paper, Hans Schumacher and his colleagues used a 2 x 4 μm spin valve based on Co-Fe-Ni to measure the magnetic reversal of a single bit. Using transverse field pulses, the researchers were able to achieve stable, reversible, and highly efficient magnetization switching. Moreover, they found that for long pulses the magnetization reversed and then returned to its original polarization in a periodic fashion.

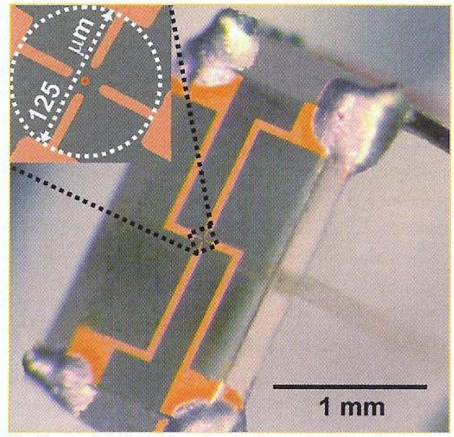
In the second paper, the team followed a single magnetization reversal in a similar 5 x 2.3 μm spin valve memory cell in real-time using time-resolved magnetotransport measurements. By stopping the transverse magnetic field pulse after a 180° precession rotation, the researchers were able to determine the fundamental ultrafast limit of field-induced magnetization reversal. For this spin valve, the researchers report a reversal time as short as 165 ps. Using ballistic switching could enable ultrafast, low power magnetic random access memories with GHz clock rates.

On the tip of a fiber

ELECTRO-OPTICS

Scientists from Brookhaven National Laboratory, Bell Laboratories, and the University of Minnesota have built a liquid crystal-based optical modulator [*Appl. Phys. Lett.* (2002) 81 (27) 5243].

Current optical transmission systems include polarization mode dispersion (PMD) compensation devices at regular intervals to control the polarization of the optical pulses, which are distorted both by the fiber itself and external mechanical vibrations. "Most designs for these distortion-correcting devices rely on lithium niobate in spite of the high cost associated with these materials," explains Ron Pindak of Brookhaven National Laboratory. But, adds coauthor John A. Rogers of Bell Labs, "Conventional wisdom suggested that liquid crystals could never achieve the necessary speeds." There is a way around this problem, however, as Bharat R. Acharya explains. "In our approach, you initially apply an electrical 'overdrive pulse' that is oriented to turn the liquid crystal molecules by 70°, but then you immediately stop the pulse after the molecules have rotated by only 1°. In this way, the molecules rotate by 1° much faster than if you had applied a pulse with the same speed to turn them by only 1°." In fact, say the researchers, the pulsed driving scheme decreases the switching time by more than a factor of 50.



Liquid crystal device built on the tip of an optical fiber. (Credit: Bell Laboratories.)

The electro-optic modulator consists of a cell made up of two pairs of 300 Å gold electrodes, which are patterned onto glass substrates and coated with a thin layer of polyimide, and filled with a nematic liquid crystal. The new type of device can achieve rotational speeds of 1°/ms and has other advantages, say the researchers. "Its speed is fast enough for these corrections, it is also reset free, and has potential to be low in cost," says Pindak. The devices are also nonmechanical in operation and have low power consumption. "The devices themselves can be built right on the tip of an optical fiber, in a very compact and attractive geometry," adds Rogers.

Long-distance teleportation

QUANTUM COMMUNICATION

The concept of quantum teleportation – of quantum states, not matter and energy – was first hypothesized in 1993 and experimental demonstrations have followed surprisingly quickly. The latest of these comes from a team of European researchers from the University of Geneva and the Danish National Research Foundation Center for Quantum Optics.

Nicolas Gisin's team and coworkers report the first long-distance demonstration of probabilistic quantum teleportation [Marcikic, I., *et al.*, *Nature* (2003) **421**, 509]. Qubits carried by 1.3 μm wavelength photons were successfully teleported to 1.55 μm wavelength photons in an adjacent lab – only 55 m away, but connected by 2 km of standard optical telecommunications fiber.

The team's teleportation strategy differs from previous demonstrations in that it uses superposition and entanglement of time-bins (i.e. distinguishing basic states by their time of arrival) to encode the qubits, rather than polarization. This kind of encoding is more robust against decoherence in optical fibers, say the researchers.

The main foreseeable application is in quantum communication, particularly quantum cryptography over larger distances, say the researchers, despite limitations imposed by the probabilistic nature of the system.