From: Microelectronics Technology Alert 20Jun2001

EFFICIENT SPIN-ELECTRON INJECTION

Spintronics, the effort to use the spins of electrons in addition to their charges to encode information, may have taken a step forward this week. A team of researchers from the University of Arkansas report in a journal Science (Science 292: 1518-1521) that they have developed a way to efficiently inject a current of spin-polarized electrons into a semiconducting material.

Every electron has both a charge and a spin, either "up" or "down." Present-day computing devices utilize just the charge of the electron--presence of a charge, or "on," translating as a one in a computer's binary code, while absence of a charge, "off," translates as a zero. However, many researchers believe that by finding a way to efficiently make use of spin properties in addition to charge properties of electrons, devices that can compute more rapidly as well as more efficient means of transmitting and storing information can be realized.

However, when scientists have attempted to inject streams of spin-polarized electrons into semiconductor materials in the past, a large percentage of the electrons flipped their spins. The highest spin efficiency previously recorded was 40% at 10 degrees K, below a reasonable operating temperature for most electronic devices.

"One of the most difficult challenges in creating "spintronic" devices is the ability to transfer the polarized electrons from a ferromagnetic material into a nonferromagnetic semiconductor without substantially de-grading the polarization," said Vincent LaBella, one of the authors of the paper.

LaBella and colleagues at the University of Arkansas report that they have achieved a 92% efficiency rate at a temperature of 100 K, a significant improvement over previous levels. They inject 100% polarized electrons into a gallium arsenide (GaAs 110) surface using a magnetic nickel scanning tunneling microscope (STM) tip. The surface can be cooled down using only liquid nitrogen.

There is, however, a catch-the surface must be smooth. In areas of the semiconductor surface where there were atomic 'steps,' the spin of the electrons became disrupted and the efficiency was lost. "Until now, no one has pinned down the fact that steps scatter spins," said LaBella.

Attempting to inject electrons into an area with steps caused the injection efficiency to drop by a factor of about six. The researchers theorize that the "metallic nature" around the steps are a source of electron distruption, causing the spins to flip.

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