HIGH SPEED LOW POWER MAGNETIC DEVICES BASED ON CURRENT INDUCED SPIN-MOMENTUM TRANSFER

Principal Investigators:
A. D. Kent, B, Özyilmaz and E. Gonzalez Garcia
Department of Physics, New York University

Background:
New magnetic devices enable ultrafast, light, low power, non-volatile, radiation-hard and inexpensive memory devices far superior to that of conventional random access memories (RAM). In contrast to conventional RAM, magnetic RAM (MRAM) uses magnetism instead of electrical charge to store data. Like in a computer hard disk, data is stored by exploiting the direction of polarization of magnets in the device. This polarization cannot be “drained” away like charge so the data storage is non-volatile and does not need to be periodically refreshed, which is crucial for maximum energy efficiency. Further, in MRAM data is accessed rapidly, eliminating the delays inherent to magnetic hard drives and enabling “instant startup” of computers and other electronic devices.

MRAM technology has been demonstrated and initial products will soon reach the market. However, the mechanism underlying present MRAM limits the memory density and speed. The fabrication of present MRAM chips is also complicated and, hence, expensive. Conventional MRAM relies on external magnetic fields to change the polarization direction of the magnets in the device. These magnetic fields invariably spread out in space limiting not only the storage density of devices based on this concept but also their ability to operate at the nanometer scale. Further, the speed of such devices is limited because the applied magnetic fields are small and random forces are used to initiate data storage.

Description of Project:
This invention exploits the groundwork done in the development of conventional MRAM while eliminating these fundamental limitations of present MRAM technology. An electrical current that flows directly through a device is used to transfer spin angular momentum between thin film magnetic elements and write data. This current acts only on the magnetic layer used to store the information, enabling a higher density memory. Importantly, writing data does not require random forces enabling extremely fast operation (down to 30 psec write times). The invention works at the nanometer scale and is a more reliable magnetic storage device. Data readout is by measurement of the device resistance, which depends on the relative polarization directions of the magnetic layers in the device, as in conventional MRAM.

Applications:
Applications of this invention include computer RAM to replace SRAM and DRAM and memory in cell-phones, PDAs, digital cameras and other portable electronic devices that would benefit from the significant reductions in size and power requirements. There are also important military applications of this technology because it will be light, fast, ultra-high density, low power and radiation hard. The latter characteristics are essential for electronics operating in space and in the open field.

Patent Status:
A provisional US patent application has been filed.

For further Information please contact:

New York University
Office of Industrial Liaison
650 First Avenue
New York, NY 10016
Tel: (212) 263-8178 Fax: (212) 263-8189