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Towards Fully 3-Dimensional MRAM

Spintronics could have a revolutionary impact on microelectronics and data storage if it provides the enabling step for transforming today's planar 2-dimensional devices into volume-filling 3-dimensional devices, where the data storage and processing capacity are related to the minimum feature size of the fabrication process, F, by F^-3 instead of F^ -2. Recently, we proposed a new approach to 3-dimensional spintronics in which topological kink solitons in multi-layered magnetic nanostructures are used to code and move data. Such solitons can be extremely stable at room temperature, highly compact, 3nd easily injected, detected and synchronously propagated. As such, they are interesting candidates for use in ultrahigh density 3-dimensional MRAM devices. During this talk I will show the first experimental demonstration of a vertical shift register based on this principle and operating at room temperature. Eleven perpendicularly magnetised CoFeB layers coupled by Ru interlayers allow solitons coding binary '0' and '1' to be injected into the bottom layer and then propagated during eight successive clock edges up the stack, eventually exiting at the top layer.

Viktor Sverdlov, Technische Universität Wien (sverdlov@iue.tuwien.ac.at) with Siegfried Selberherr

MOSFET and Spin Transistor Simulations

The breathtaking increase in performance and speed of ICs became possible by continuous miniaturization of CMOS devices. The success of the microelectronics technology has been enabled and supported by sophisticated TCAD tools. The TCAD related cost reduction share amounts to 40%. Employing spin of an electron is promising for boosting the efficiency of future low-power ICs, and TCAD tools must include spin transport in order to meet the demands. Because of recent ground breaking experiments on spin injection and spin transport at room temperature silicon is gaining momentum for applications involving spin. Requirements for making a spinFET are discussed. Alternative spin-based switches will be shortly reviewed.

Hanan Dery, Rochester University (hanan.dery@rochester.edu) with Igor Zutic

Silicon Spin Communication

Ron Jansen, AIST Tsukuba (ron.jansen@aist.go.jp)

Electrical and Thermal Spintronlcs in Silicon

Almost a century after its discovery, a basic quantum mechanical property of the electron, namely its spin, is being considered as an alternative for encoding digital information. The use of electron spin in electronic devices has already led to many fascinating phenomena and continues to produce new ones. The field, now called "spintronics", combines magnetic, electric, optical and thermal effects in a wide variety of materials. Of particular interest is the integration of magnetism and mainstream semiconductors such as silicon, as this will have the most significant impact on information technology. We will discuss the remarkable progress made in recent years with spins in semiconductors, focusing on the implementation of spin-based electronic functionality in silicon devices and the associated challenges. Two of our recent advances will be highlighted:

The electrical injection and detection of spin polarization in n-type and p type Si at room temperature using a ferromagnetic tunnel contact, and the manipulation of the spins in a transverse magnetic field (Hanle effect).

The creation of spin polarization in Si by a thermal spin current and the associated discovery of Seebeck spin tunneling, allowing thermal transfer of spins from a ferromagnetic contact into non-magnetic materials without a charge tunnel current.