

## THE SPIN ON ELECTRONICS!

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### Abstract

Recent advances in generating, manipulating and detecting spin-polarized electrons and electrical current make possible new classes of spin based sensor, memory and logic devices<sup>1</sup>. One key component of many such devices is the magnetic tunneling junction (MTJ) - a sandwich of thin layers of metallic ferromagnetic electrodes separated by a tunneling barrier, typically an oxide material only a few atoms thick. The magnitude of the tunneling current passing through the barrier can be adjusted by varying the relative magnetic orientation of the adjacent ferromagnetic layers. As a result, MTJs can be used to sense the magnitude of magnetic fields or to store information. By altering the composition and thicknesses of an MTJ's layers, its properties can be "magnetically engineered" via phenomena such as exchange bias and oscillatory interlayer coupling to match its properties to a particular use, such as the ultra-sensitive data-reading elements within magnetic hard-disk drives, or the storage elements in non-volatile magnetic random access memories (MRAMs). Prototypes of cross-point architecture MRAMs using MTJ cells have demonstrated the possibility of a highly attractive highperformance, high-density non-volatile memory technology<sup>2</sup>. The electronic structure of the ferromagnet together with that of the insulator determines the spin polarization of the current through an MTJ -- the ratio of 'up' to 'down' spin electrons. The spin polarization can reach 80% for conventional 3d ferromagnets, such as CoFe, so that magnetic tunnel injectors are promising sources of spin polarized current for potential spintronic devices based on spin transport in semiconductors. The magnetic tunnel transistor, a three terminal device based on spin- filtering, is another possible source of nearly 100 percent spin-polarized current<sup>3, 4</sup>. Such sources may be important for the emerging field of spin-based semiconducting electronic devices.

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