ULTRA HIGH NONVOLATILE FERROELECTRIC RANDOM ACCESS MEMORY

University of Arkansas physicists have shown that low-dimensional nanoscale structures of piezoelectric materials retain their ferroelectric properties even though the piezoelectric effect disappears at the nanoscale. What happens is that the polarization of the material at the nanoscale produces a vortex where the charges swirl in a circular pattern, so that they cancel each other. The vortex of charge can then have either a clockwise or counterclockwise spin which opens up the possibility of using the spin state of the vortex to stand for either a "1" or a "0".

Simulations by the scientists resulted in a method of changing the spin state of the vortex – allowing the possibility of writing a "1" or a "0" on each specific nanostructure such as a nanodot. The ability to change the spin state of the nanodot is based on the application of inhomogenous electric fields. Static electric charges can be placed near the nanodot and when they are switched or moved, the spin of the nanodot changes. Nanodots can then be used as memory cells, and because of the very small size of the nanodots, the density of the memory elements can go up dramatically from the 1 billion bits per square inch now achieved with magnetic recording to 80 trillion bits per square inch, or about 4 orders of magnitude greater memory density.

The use of nanodots of ferroelectric material to store information is especially helped by the use of the vortex spin state to record the bits, because the vortex has a closed electric field that will not interact with neighboring nanodots, thus eliminating cross-talk between the memory elements. Cross-talk in conventional memory cell capacitors requires the use of passgate transistors to deal with the problem of cross talk.

In addition to making memory elements for ultra-dense non-volitile ferroelectric random access memory (NFERAM's), the use of ferroelectricity in nanoscalestructures can be applied to piezoelectric sensors, efficient actuators, nano-scale dielectric capacitors for energy storage, and nano-scale ultrasounds for medical use.

The technology is patent pending and is available for licensing. The University of Arkansas seeks partners to further develop the technology and to commercialize the applications.

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