Study: nanostructures hold promise as fast, tiny RRAM switches

15 January 2010

Jay A. Switzer's research may lead to advances in computing and resistive random access memory (RRAM)

(PhysOrg.com) -- Building microscopic materials known as superlattices on the surface of gold may lead to a treasure for researchers interested in faster, smaller, and more energy efficient computing devices, say researchers at Missouri University of Science and Technology.

Dr. Jay A. Switzer and his colleagues at Missouri S&T report in the *Journal of the American Chemical Society* that they have constructed a type of superlattice that shows "unique low-to-high and high-to-low resistance switching that may be applicable to the fabrication of an emerging memory device known as resistive random access memory," or RRAM.

With RRAM, a material that is normally insulating can be made to conduct through a filament or conduction path formed after a high enough voltage is applied.

The researchers' paper, titled Resistance Switching in Electrodeposited Magnetite Superlattices, appears on the journal's ASAP ("as soon as publishable") website and will appear in an upcoming issue.

Superlattices are nanometer-scale structures made up of two materials layered on top of each other, like the alternating bread and meat in a club sandwich. A nanometer - visible only with the aid of a high-power electron microscope - is one billionth of a meter, and some nanomaterials are only a few atoms in size. By experimenting with materials at the nanometer level, researchers find that even common materials exhibit unusual properties. For example, metals developed at the nanometer scale may have fewer defects and could lead to stronger materials for construction. Semiconductors and magnetic materials developed at the nanometer scale may have different properties than the bulk material.

At Missouri S&T, Switzer and his colleagues produced two types of superlattices - known as defect-chemistry and compositional superlattices - from the materials magnetite and zinc ferrite. They then "grew" the materials on the single-crystal gold placed in a beaker filled with a solution.

The superlattices grown via the defect-chemistry method appear to hold promise for RRAM devices, Switzer says, because the resistance of the superlattice is a function of the applied bias. The fact that multiple resistance states can be accessed by simply varying the applied voltage opens up new possibilities for multi-bit data storage and retrieval.

Switzer's co-authors for the Journal of the American Chemical Society paper are Rakesh V. Gudavarthy, Guojun Mu, and Zhen He, all graduate students in the chemistry department at Missouri S&T; Andrew J. Wessel, an undergraduate student in the chemistry department at Missouri S&T; and Dr. Elizabeth A. Kulp, a postdoctoral associate at Missouri S&T.

Last fall, Switzer and his colleagues reported in *Chemistry of Materials* that a simple, inexpensive process of growing zinc oxide "nanospears" could also lead to new materials for solar cells, ultraviolet lasers, solid-state lighting and piezoelectric devices (see Tilted Epitaxial ZnO Nanospears on Si(001) by Chemical Bath Deposition).

More information:
pubs.acs.org/doi/abs/10.1021/ja909295y

Provided by Missouri University of Science and Technology