Glorious gadolinium gives flash memory a future

August 24 2010

Future flash memory could be faster and store more data without changing its basic design by using a clever nanocrystal material proposed by scientists at Taiwan's Chang Gung University, who describe a new logical element made with the rare earth material gadolinium in the journal *Applied Physics Letters*.

It's well known in the semiconductor industry that conventional flash memory -- an essential element of mobile electronics today -- cannot improve much more because continued shrinking of its floating gate structure in the pursuit of faster performance and higher data storage capacity will soon degrade its ability to retain its memory. The situation has stimulated a wide range of research worldwide into dozens of alternative memory designs, but most attractive to industry would be one that requires the least modification to the existing floating-gate design.

A research group headed by Chao-Sung Lai at Chang Gung University in Taoyuan, Taiwan, has done just that. They have demonstrated that a cleverly modified floating gate made of gadolinium oxide -- an inexpensive rare-earth compound already used in other microelectronic applications -- has the write/erase speed and data retention properties that will enable smaller, faster and higher-capacity flash memories in the future.

"The low-voltage and low-power operation of this memory should make it especially attractive for future smartphones and other telecommunications applications," said Dr. Lai.

The Chang Gung researchers made two key insights that enabled their success. Last year, they realized that taken together, crystallized and amorphous gadolinium oxide had electrical properties that were close to those needed for future floating-gate flash memories. After creating gadolinium oxide nanocrystals within a matrix of its amorphous form, they then exposed it to a fluorine-containing plasma, which boosted the materials' properties to the desired level. Since all of the materials and processes they used are well-known in the semiconductor industry, Dr. Lai is optimistic that this design will ultimately be commercially successful.

More information: The article, "Nano-Structure Band Engineering of Gadolinium Oxide Nanocrystal Memory by CF4 plasma Treatment" by Jer-Chyi Wang, Chih-Ting Lin, Chao Sung Lai and Jui-Lin Hsu will appear in the journal *Applied Physics Letters*. See: apl.aip.org/resource/1/applab/v97/i2/p023513_s1

Provided by American Institute of Physics