Magnetic properties of silicon nano-ribbons

Oak Ridge National Laboratory

OAK RIDGE, Tenn., Oct. 17, 2012 — Nano-ribbons of silicon configured so the atoms resemble chicken wire could hold the key to ultrahigh density data storage and information processing systems of the future.

This was a key finding of a team of scientists led by Paul Snijders of the Department of Energy's Oak Ridge National Laboratory. The researchers used scanning tunneling microscopy and spectroscopy to validate first principle calculations - or models - that for years had predicted this outcome. The discovery, detailed in New Journal of Physics, validates this theory and could move scientists closer to their long-term goal of cost-effectively creating magnetism in non-magnetic materials.

"While scientists have spent a lot of time studying silicon because it is the workhorse for current information technologies, for the first time we were able to clearly establish that the edges of nano-ribbons feature magnetic silicon atoms," said Snijders, a member of the Materials Science and Technology Division.

The surprise is that while bulk silicon is non-magnetic, the edges of nano-ribbons of this material are magnetic. Snijders and colleagues at ORNL, Argonne National Laboratory, the University of Wisconsin and Naval Research Laboratory showed that the electron spins are ordered anti-ferromagnetically, which means they point up and down alternatingly. Configured this way, the up and down spin-polarized atoms serve as effective substitutes for conventional zeros and ones common to electron, or charge, current.

"By exploiting the electron spins arising from intrinsic broken bonds at gold-stabilized silicon surfaces, we were able to replace conventional electronically charged zeros and ones with spins pointing up and down," Snijders said.

This discovery provides a new avenue to study low-dimensional magnetism, the researchers noted. Most importantly, such stepped silicon-gold surfaces provide an atomically precise template for single-spin devices at the ultimate limit of high-density data storage and processing.

"In the quest for smaller and less expensive magnets, electro-motors, electronics and storage devices, creating magnetism in otherwise non-magnetic materials could have far-reaching implications," Snijders said.

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DOE Office of Science, premier national user facilities for interdisciplinary research at the nanoscale. Together the NSRCs comprise a suite of complementary facilities that provide researchers with state-of-the-art capabilities to fabricate, process, characterize and model nanoscale materials, and constitute the largest infrastructure investment of the National Nanotechnology Initiative. The NSRCs are located at DOE's Argonne, Brookhaven, Lawrence Berkeley, Oak Ridge and Sandia and Los Alamos national laboratories. For more information about the DOE NSRCs, please visit http://science.energy.gov/bes/suf/user-facilities/nanoscale-science-research-centers/

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