Los Alamos shares Nano 50 award for directed assembly

September 3, 2008

Contribution to Nanotechnology Manufacturing

LOS ALAMOS, New Mexico, September 3, 2008—A team of scientists spanning three institutions, including Los Alamos National Laboratory, has discovered a more efficient way of fusing charge-carrying electrical contacts to tiny “nanowires” of silicon to create the nanotechnology at the heart of potential future advances in modern electronics, sensing, and energy collection.

Nanotech Briefs, a newsletter focusing on design engineering for tomorrow’s nanotech products, selected this work, published on July 17, 2007, in Applied Physics Letters, to receive one of the 2008 Nano 50 Awards that recognize “the top 50 technologies, products, and innovators that have significantly impacted, or will impact, the development of nanotechnology.”

The difficulty and cost of forming these critical metal-silicon junctions have significantly hindered large-scale fabrication required for applications in which tiny nanowires must be integrated into such systems as sensor arrays or solar cells. In each case, whether detecting specific molecules as they attach to the nanowire in a sensor array or absorbing energy from the sun, the contacts must allow the easy flow of electrical current in and out of the nanowires.

Current nanomanufacturing relies on ultra-high resolution patterns, or “masks,” to accurately fabricate the connections between metal contacts, such as nickel and the silicon nanowires. The technique currently calls for what’s known as electron beam lithography to separately connect the metal contacts to each nanowire. This process, in which the wire pattern is “written” with a beam of electrons to one nanowire at a time, is much too slow for practical application.

“From the microelectronics manufacturing approach, anything that takes a long time is just not cost effective,” said Tom Picraux, a Los Alamos researcher with the Center for Integrated Nanotechnologies (CINT), who was formerly based at Arizona State University.

To meet this challenge, Picraux and his Arizona State doctoral student Sarang Ingole, as well as Paven Aella of Arizona State and CINT scientist Sean Hearne of Sandia National Laboratories in Albuquerque, New Mexico, designed a method that eliminates the final lithography step.

The team used lithography initially to create a set of gold electrodes. They then took advantage of an alternating electric field in a technique called dielectrophoresis to pull the silicon nanowires from a solution into place between the electrodes. Again using an electric field, this time in concert with a mild acid bath, the researchers selectively deposited the nickel only where the underlying Au electrodes were located until the silicon nanowires were completely buried and then heated them to several hundred degrees Celsius to establish good contacts.

With this “directed assembly” approach, the electric field guides the simultaneous creation of all the contacts in the correct location at once. The process doesn’t require lithography for completing the final connection to the nanowires, thereby increasing its potential for use in cost-effective nanotechnology manufacturing of existing technology such as electronic switches. The scheme may also increase the feasibility of larger-scale applications including biological and chemical sensor networks to detect potential threats, as well as the fabrication of nanowire solar cells for extracting the near-limitless source of clean energy solar cells could provide in the future.

The Center for Integrated Nanotechnologies is a Department of Energy/Office of Science Nanoscale Science Research Center (NSRC) operating as a national user facility devoted to establishing the scientific principles that govern the design, performance, and integration of nanoscale materials. Los Alamos and Sandia National Laboratories jointly manage the center. CINT was an ideal place to “grow” these ideas on integrating nanowires into devices, Picraux said, emphasizing that this body of work could serve as a model for future collaborative research across multiple institutions.

“Taking advantage of the different skills and capabilities at all three locations, we were able to come up with something pretty cool,” he said.

The team will receive the award at the NASA Tech Briefs National Nano Engineering Conference held November 12 and 13 in Boston, Massachusetts. More information on the Nano 50 Awards and the meeting is available at www.techbriefs.com/nano.


NNSA
National Nuclear Security Administration