Researchers develop technique that could open doors to faster nanotech commercialization

An innovative method allows silicon nanowires and carbon nanotubes to grow directly on mic room temperature chamber

07/04/2003 - Engineers at the University of California, Berkeley, have found an innovative wa nanowires and carbon nanotubes directly on microstructures in a room temperature chambe doors to cheaper and faster commercialization of a myriad of nanotechnology-based devices

The researchers were able to precisely localize the extreme heat necessary for nanowire an growth, protecting the sensitive microelectronics - which remained at room temperature - jus micrometers away, or about one-tenth the diameter of a strand of human hair.

The new technique, described in the June 24 online issue of the journal Applied Physics Lett cumbersome middle steps in the manufacturing process of sensors that incorporate nanotub An image of the technique will be featured on the cover of the journal's June 30 print issue.

Such devices would include early-stage disease detectors that could signal the presence of a an ultra-sensitive biochemical sensor triggered by mere molecules of a toxic agent.

"One very big problem right now is figuring out how to assemble these nanowires or nanotub microchip in a way that is commercially feasible," said Liwei Lin, associate professor of mech engineering at UC Berkeley.

Lin tested the new technique for processing nano-based microelectromechanical systems (M with his graduate students Ongi Englander, lead author of the paper, and Dane Christensen, paper.

Shown above are oblique and closeup views of silicon nanowire growth. The nanowires are to 35 micrometers of a 100 micrometer-long microstructure. (Courtesy Bob Prohaska and Or

The steps used in creating nanowires and nanotubes are essentially the same, though differ temperatures may be used. "It's like a recipe," said Englander. "Different ingredients are use whether you want to make a chocolate chip muffin or a banana nut muffin, but the steps are same."

The UC Berkeley researchers, in this case, used a gold-palladium alloy with silane vapor to c nanowires, and a nickel-iron alloy with acetylene vapor to create carbon nanotubes.

The typical nanowire or nanotube production process occurs in a furnace at temperatures of degrees Celsius (1,112 to 1,832 degrees Fahrenheit). The procedure begins with a 1 square wafer that is coated thinly with a metal alloy. A vapor is then directed towards the substrate, alloy acts as a catalyst in a chemical reaction that eventually forms billions of nanowire or na precipitates.

The nanomaterials are harvested by being placed in a liquid solvent, such as ethanol, and bl
ultrasonic waves to loosen them from the wafer surface. Researchers must then sort through
nanowires or nanotubes to find the few that meet the specifications they need for their senso

Correctly orienting a nanowire onto a 5 square millimeter microchip would be like sticking a s
a football field with an accuracy of a few micrometers.

"If I had the right pair of tweezers, I could pick out the nanowire that I wanted and manipulate
tweezers don't exist," said Englander.

So instead of finding a way to produce nanomaterials separately and then connecting them t
systems, the researchers decided to grow the silicon nanowires and carbon nanotubes direc
board.

The challenge was in protecting the sensitive microelectronics that would melt in the tremend
temperatures needed to create the nanomaterials.

Resistive heating provided the answer. "It's the same idea as the wires in a toaster," said En
electrical current flows through the wire to generate the heat."

The researchers passed the current through a wire to the specific locations on the microstruc
wanted the nanowires or nanotubes to grow. In one experiment, an area was heated to 700 d
while another spot just a few micrometers away sat comfortably at 25 degrees Celsius. The e
was placed in a vacuum chamber for the tests.

"It's the immediate integration of the nanoscale with the microscale," said Christensen, who w
carbon nanotube experiments.

The experiments yielded silicon nanowires from 30 to 80 nanometers in diameter and up to 1
long, and carbon nanotubes that were 10 to 30 nanometers in diameter and up to 5 microme

"This is a very unique approach," said Lin. "This method allows the production of an entire na
in a process similar to creating computer chips. There would be no post-assembly required."

The researchers are continuing experiments to fine-tune the temperatures and length of hea
desired lengths of nanowires and nanotubes.

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Additional information

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