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Chips sprout bitty wires
New process brings nanodevices closer to practical use

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In a study that could bring a future world of powerful nanotechnology devices a bit closer, a UC Berkeley research team has figured out how to "grow" nanoscale wires directly on a silicon chip.

Associate Professor Liwei Lin and two graduate students have found a way for manufacturers to bypass an unwieldy nano-fabrication process that now stands in the way of creating exquisitely sensitive biohazard detectors or next-generation computers.

Although the method has been used only in the lab so far, Stephen Empedocles, the co-founder of Nanosys Inc. in Palo Alto, said it has potential as a scaled-up process for commercial production.

Scientists long have recognized the possibilities for advanced technologies using silicon nanowires or carbon nanotubes -- filaments with diameters measured in billionths of a meter, a small fraction of the width of a human hair. In an ultimate example of miniaturization, biosensors using carbon nanotubes conceivably could detect a single dangerous virus particle.

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The nanowires and nanotubes could be incorporated into the circuitry of computer chips, transmitting signals to conventional microelectronic elements that lead to display screens or other devices.

But connecting those delicate nanofibers to silicon chips poses a formidable challenge, said Dane Christensen, 25, who just finished his second year of graduate school in mechanical engineering.

Nanofilaments can be produced in batches of billions, but researchers then must use microscopic tools or electronic fields to select one of the right length, and then transfer it to the right place on the computer chip, Christensen said.

"Both of those are pretty clunky methods," he said.

But trying to form the minute fibers in place on a chip raises an even more challenging hurdle: carbon nanotubes and silicon nanowires are usually forged in a furnace as hot as 1,832 degrees Fahrenheit. Any circuit board would be fried under such conditions.

The UC Berkeley team developed a way to confine the intense heat to the site where the nanofiber forms, while maintaining room-temperature conditions for the fragile microelectronic elements that would rest nearby -- within a tenth of the width of a strand of hair.

To do this, they suspended a tiny silicon bridge or microstructure over the chip. Along the top of the bridge, they placed one of the nanofiber ingredients -- a thin strip of metal-alloy catalyst. After adding gases that supply either silicon or carbon, they passed a stream of current through the silicon bridge, causing it to heat up.

Nanowires or carbon nanotubes then sprout from the particles of metal catalyst, in a process that Christensen said physicists still can't quite explain. The loose ends of the filaments could then be connected at other ends of the chip, where they could become part of a functioning circuit.

An intriguing concept, said one industry expert.

"I think that could be a very interesting path forward," said Empedocles. "Of course, there's a big step between an academic proof of concept and a commercially manufacturable product."

But Empedocles said such academic research is worth watching. One of Nanosys' major projects is the production of higher-efficiency, lower-cost solar cells based on inventions by a UC Berkeley scientist.

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