PURSUIT OF A SMALL TECH BUILDING BLOCK GOES DOWN TO THE NANOWIRE

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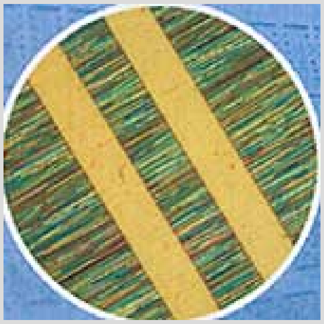
Jan. 19, 2004 – When is a wire more than a wire? When you add the "nano" prefix, of course.


Nanowires are pinned under two electrodes.

On one level, "nanowire" is a literal term: a channel for electrons or photons no wider than a few thousand atoms. As electronic components shrink closer to the size of biological cells or molecules, such wires may eventually need to replace the strands of metal that interconnect circuits today.

But scientists have conjured fine filaments they also call nanowires that may one day serve as lasers or detectors of dangerous molecules or defective genes.

Peidong Yang (News, Web) and colleagues at the University of California, Berkeley, have, for example, directed crystals of zinc oxide, a semiconductor, to self-assemble into arrays of nanowires that function as ultraminiature lasers and might be useful for probing cells or performing more-precise surgery.

Yang's group has also put a thin layer of silver nanowires to work as a delicate chemical detector. Such a film of nanowires could be a good way to sense chemical or biological warfare agents.

Just as nanowire applications extend beyond the conventional notion of "wiring," researchers are working to fabricate very small, thin and long structures out of myriad materials. Among them: silicon and other semiconductors, quantum dots, polymers and carbon nanotubes.

They are also employing a wealth of techniques for producing nanowires, from traditional semiconductor materials to more exotic uses of DNA, viruses and proteins as templates, molds or self-assembly catalysts. In November 2003, a team of scientists reported that filaments of polymer about 100 nanometers wide could be extruded from an inkjet-type nozzle in liquid form and solidified into wires with light.

One of the most novel nanowires developed to date doesn't merely connect circuit components, but can work as an actual transistor or logic circuit. Charles Lieber's (News, Web) research group at Harvard fabricated such nanowires-as-devices by alternating bands of

different semiconductor materials as the wire is formed.

Lieber, one of the leading figures in nanowires, said his interest began in the early '90s, when "it became clear to me that moving information around at the nanoscale was going to be a premium." What he finds most exciting about the field today is that so many different devices can be made out of so many materials, with good control of the size and characteristics of nanowires.

In this sense, nanowires have, like quantum dots and carbon nanotubes, emerged as a building block for more complex nanoscale efforts.

While much work on nanowires is still years away from commercialization, both nanowires and nanotubes have already shown the ability to carry information as much as 100 times faster than conventional wiring in current consumer electronic products.

And as Dave Bishop, director of Lucent Technologies' New Jersey Nanotechnology Consortium, explained, nanowires are so phenomenally small that they may be able to take advantage of quantum effects unique to matter at the atomic scale.

In the nearer term, a first-generation commercial application of nanowires is under way at Nanosys Inc. (Profile, News, Web) in Palo Alto, Calif., and could be ready for the flat panel displays market in three to five years.

The closely watched startup has developed a process for using nanowires in thin-film-transistor (TFT) display panels now common in laptops, PDAs and liquid crystal monitors. Nanosys is also working with nanowires as a substrate material for use in a biological assay device.

As Stephen Empedocles, Nanosys co-founder and director of business development, explained, the application begins with the company's proprietary technique for making millions of threads of silicon crystal, each only 10 to 20 nanometers in diameter and as long as 100 microns.

The nanowires can then be applied at room temperature to the back surface of a display as an extremely thin coating. The wires lie flat and all point in the same direction, a little akin to a raft of logs on a river. Next, a grid of electrodes is deposited using conventional manufacturing methods on top of the nanowire film. The electrodes pin bundles of the nanowires across a gap to form the transistor elements that make up a display's pixels.

Empedocles said that the nearly perfect silicon crystal in the nanowires allows electrons to flow more easily than through the amorphous, or non-crystalline, silicon typically used in thin-film-transistor display manufacturing. That improved performance, he noted, could enable display manufacturers to produce the TFT elements and display driver electronics in one step.

And because the process is low temperature, Empedocles noted that the nanowire film could be deposited on a flexible surface in a low-cost, high-throughput process such as "roll-to-roll," much the way newspaper is printed.

On Jan. 14, Nanosys announced it would work with Intel to investigate how its nanotechnologies might work in future memory devices. The company, however, declined to specify whether such efforts would focus on nanowires.

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