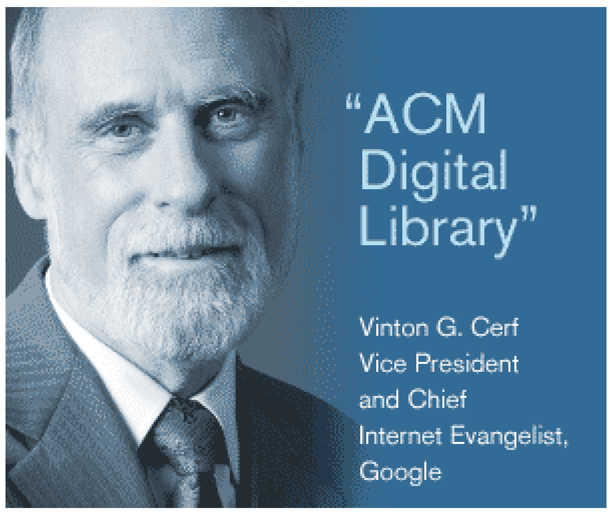
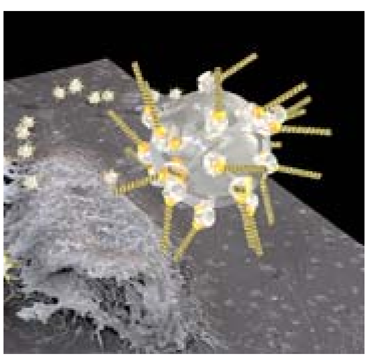


Friday, December 29, 2006

The Year in Nanotech

Dazzling displays, handheld sensors, cancer killers, and nanotube computers.

By Kevin Bullis



In this idealized image, engineered nanocarriers find and attack specific diseased cells. The stick-like objects allow the

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nanocarriers to bind to particular cells.
Credit: Patrick Hunziker, University of Basel, Switzerland

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Nanotubes light up displays.
LCD computer monitors are quickly replacing old, bulky, cathode-ray-tube (CRT) screens. But CRTs are still prized for their excellent color rendition, wide viewing angles, and fast response time. These features are now coming to the flat screen in the form of CRT-like field-emission displays, which, rather than using an electron gun a foot and a half behind the screen, light up pixels with millions of electron emitters placed within millimeters of the screen. In one version, developed by Canon and Toshiba, nanoscale gaps in a thin film emit electrons. Motorola uses carefully spaced carbon nanotubes. Field-emission displays have been around for years, but the nanotech is making them potentially less expensive, and thus competitive with other display technology. (See "High-Definition Carbon Nanotube TVs.")
Nanotech is enabling other types of displays as well. MIT spinoff QD Vision, of Watertown, MA, is developing ultrathin and potentially flexible displays based on nanoscale semiconductor crystals called quantum dots. These would require much less energy than LCDs and feature more-vivid colors.

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(See "Nanocrystal Displays.") Meanwhile, so-called electronic ink developed at MIT is starting to appear in commercial products, such as Sony's electronic book reader and a low-cost cell phone from Motorola. (See "A Good Read" and "Motorola's Dumb Phone.")

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iPod powered by sneakers?
Researchers have developed zinc-oxide nanowires that can generate electricity from body movements, potentially leading to iPod-charging sneakers. The nanowires are grown to stand on end on an electrode. When the nanowires flex in response to jolts from people walking or other movements, electronic charges shift in the material, creating electric potential, or voltage. This leads to an electrical current once the nanowire is connected to a circuit. Although each nanowire makes a tiny amount of electricity, together they can easily be grown in dense arrays large enough to power small medical implants, such as micro-glucose sensors, and perhaps eventually in consumer electronics. (See "Free Electricity from Nano Generators.")

Nanocures.
Conventional cancer treatment can wreak havoc on the body. So researchers are developing technology smaller than the cancer cells that can seek them out, slip inside, and deliver a dose of deadly cancer medicine, leaving healthy cells untouched. Polymer nanospheres developed by researchers at MIT and Harvard University trick cancer cells into engulfing them. Unlike conventional chemotherapy, which may leave behind some cancer cells that can form new tumors, the nanosphere treatment releases drugs gradually to keep the cancer from coming back. (See "Single-Shot Chemo.") In an earlier-stage project, researchers in Switzerland are developing nanotech that mimics living cells, incorporating into hollow polymer spheres proteins that can open or close in

response to signals in the environment, further improving the specificity of the treatment. (See "Cell-Like Nanoparticles for Attacking Disease.") As researchers race to develop new cancer-fighting nano tools, an important weapon will be computer modeling, which will help researchers identify materials and structures that can be used safely in the body. (See "Speeding Up Nanomedicine.") But perhaps the biggest impact of nanotechnology on health could be new ways of using nanostructures to purify water, since dirty water is a leading cause of disease worldwide. (See "Cheap Drinking Water from the Ocean" and "Cleaning Up Water with Nanomagnets.")

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By Kevin Bullis

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Finding the right nanotubes.
Carbon nanotubes have excellent electronic properties that make them attractive for use in future high-performance computers. But a given batch of carbon nanotubes can contain as many as 80 different types, each with distinct properties. While this diversity is potentially appealing, it's also one of the major obstacles to the use of carbon nanotubes. Because it's not possible to isolate carbon nanotubes by type, nanotube-based devices have either been one-off prototypes or have relied on the

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average properties of bulk nanotubes. (See "Carbon Nanotube Computers.") However, a new technique based on an ultrafast centrifuge is now enabling researchers to sort nanotubes by their electronic properties, making it far easier to study them and develop new applications. (See "Nanotube Computing Breakthrough.") Another technique, in an earlier stage of development, could be even more precise. It "clones" specific nanotubes by chopping them up and then growing new nanotubes from these fragments. (See "Cloning Nanotubes.") According to one researcher, being able to isolate nanotube types is like having access to a new periodic table.

Handheld chemical and biological sensors.
Nanowires are ideal for detecting chemical weapons and even individual virus particles. That's because when such substances bind to nanowires, even in extremely low quantities, the wires' conductivity changes markedly. Researchers are moving closer to realizing such sensors by improving the speed of nanowire transistors. (See "Nanowire Transistors Faster than Silicon.") Others have developed a method for forming two different types of nanowires on the same surface to make energy-saving circuits that will rule out false positives, improving the accuracy of nanowire sensors. (See "Nanowire Computing Made Practical.") Hundreds of nanowire transistor-based circuits could easily be incorporated into a handheld device, allowing instant detection of hundreds of important chemical and biological materials.

Mix-and-match electronic circuits.
Although they offer advantages for particular applications in computing, nanoscale structures such as nanotubes and nanowires are unlikely to completely replace conventional transistors, at least in the near future. (See "The Future of Nanoelectronics.") Indeed, it would be

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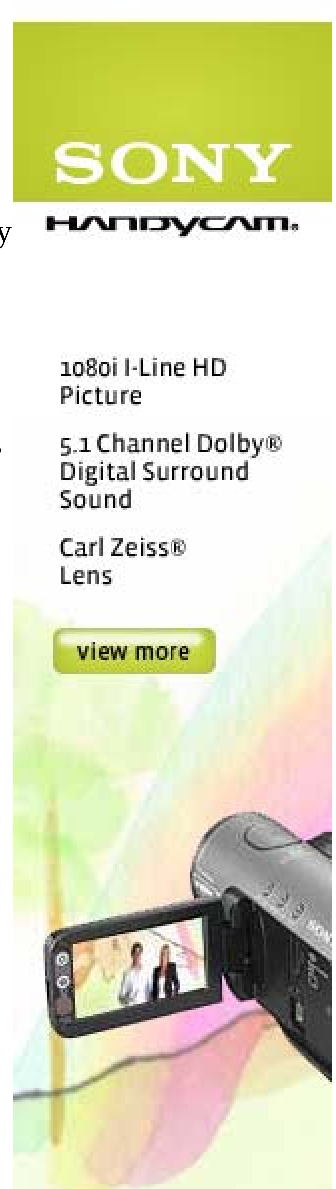

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ideal to combine various types of structures in one device, capitalizing on the strengths of each. But this isn't easy, since, for example, the temperatures required for processing one material or structure can damage others. Researchers at the University of Illinois, Urbana-Champaign, have developed an inexpensive way to integrate all sorts of materials and structures onto the same surface--and the surface can even be a flexible polymer. Different types of materials can be laid down side by side or on top of each other in successive layers. This could lead to cheaper, more compact night vision for soldiers and even flexible displays that are scaled-down versions of the bright and vivid LED-based displays found in sports arenas. (See "Making Nanoelectronics for Displays.")

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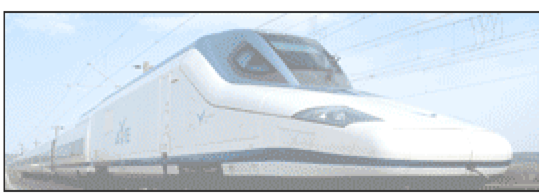
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