NANOELECTRONICS MEANS MORE THAN SIMPLY SHRINKING SEMICONDUCTORS

By Jack Mason
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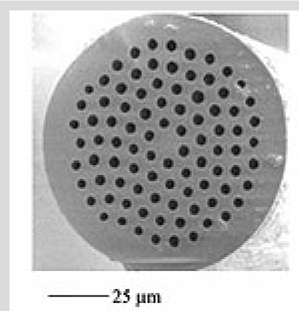
NEW YORK, Dec. 13, 2002 – Of all small tech subjects, nothing stirs debate about the difference between "nanoscale" and "nanotechnology" like nanoelectronics.

Lucent Technologies

Nanoscale contact printing techniques being developed by Lucent and E Ink produce plastic electronic circuitry for billboard-size displays and "electronic paper" – low cost, flexible and lightweight sheets that could be produced like newspaper and re-used

Some experts contend that chip makers today may be working at the nanoscale – with insulating layers in advanced processors a mere 2 nanometers thick – but they are not (yet) operating in the realm of true nanotechnology.

Others argue that today's most sophisticated semiconductor devices not only reach deep into the nanometer realm, but also harness advanced and precise quantum effects that occur only in the supersmall world. Indeed, leveraging and controlling such atomic phenomenon is one of the hallmarks of nanotechnology.



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Nanofluidic channels modulate movement to control, shape and filter optical signals passing through fiber, eliminating the need for external tuners, equalizers or other signal processing equipment.

The debate surrounding nanoelectronics may not be settled for 5 to 10 more years, when complex devices may be built around transistors made of designer molecules, carbon nanotubes or other materials that are unquestionably nano in dimension and function.

In the meantime, a recent Nanoelectronics Planet conference in Manhattan revealed that a few nanoelectronic applications – in fiber optics communications and ultra-high-capacity hard drives – are, like images in some side-view mirrors, closer than they may appear.

John Rogers, director of nanotechnology research at Lucent Technologies' Bell Labs, described a new type of optical fiber the company is developing that can be tuned with nano-imprinted circuitry and nanofluidic channels. Moreover, Rogers said the tunable fiber was about nine months away from commercialization.

Metallic circuitry is applied to the outside of the fiber via an inexpensive nanoscale contact imprinting technique. The tiny wiring is applied by rolling the fiber diagonally across a surface etched with rows of raised nanogrooves.

Current applied to the resulting coil of wiring creates heat that moves fluid inside tiny channels in the glass strand. The fluid's carefully modulated movement is designed to control, shape and filter optical signals passing through the fiber, eliminating the need for external tuners, equalizers or other signal processing equipment.

Rogers said Lucent is also using nanoscale contact printing techniques to produce plastic electronic circuitry for billboard-size displays and "electronic paper" – low cost, flexible and lightweight sheets that could be produced like newspaper in a reel-to-reel high speed process and re-used with downloadable data.

The company has been collaborating with E Ink Corp. of Cambridge, Mass., on the electronic paper project. Bell Labs, DuPont and the Sarnoff Institute recently won $12 million in funding from the National Institute of Standards and Technology to develop methods for producing such plastic circuitry, as Rogers hopes, "by the square mile."

Nanomagnetics Ltd., founded in 1997 in Bristol, England, also has nanotechnology ready for the multibillion-dollar hard disk drive market. Eric Maynes, the company's chief technology officer, said that Nanomagnetics has developed a small tech process for increasing the density of hard drives to as much as 200 gigabits per square inch. The highest density drives on the market today squeeze a little more than 50 gigabits into a square inch.

According to Maynes, Nanomagnetics achieves such ultrahigh density by embedding ferritin protein molecules with magnetic particles and getting them to assemble into a very tightly packed and uniform thin film.

Tom Theis, director of physical sciences research at IBM's Watson Research Center in Yorktown Heights, N.Y., said that computing components such as memory, logic and sensors are where true nanotechnology for the electronics industry will first appear.

In the memory market, he noted, Nantero Inc. and Zettacore Inc. aim to build computer memories with carbon nanotubes and molecules. Theis said IBM, Motorola and many other established companies are racing to commercialize MRAM (magnetic random access memory) a technology in development for decades that would use less power and allow electronic devices to boot up instantly.

Theis said that recent advances in building MRAM memory with nanostructures called magnetic tunnel junctions have made the technology a commercial priority. "We're interested in molecular memory, but we're not putting 50 people on it, like we are with MRAM," Theis said.

Theis did say that he had "no doubt" that semiconductor materials that self-assemble with the aid of advanced chemical synthesis will help silicon microelectronics evolve into nanoelectronics over the next 10 years.

Theis also predicted that in less time, conventional processes for making chips via photolithography would be assisted by techniques for getting molecules to self-assemble into nanoscale patterns. Theis said IBM is already working with special molecules to do self-assembly on specific areas of a chip.

Using molecules as fabrication materials will, he said, produce structures "orders of magnitude smaller" than anything that can be built with photolithography.

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