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Top Five Nanotech Breakthroughs Of 2006

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NEW YORK - This year saw a slew of remarkable nanotech breakthroughs, and narrowing down the top five was no easy task. One major theme of 2006 was the intersection of computing and biology--integrated circuits were used to study everything from neural activity to tissue dynamics, and disposable bio labs-on-a-chip became a reality.

One Harvard research team, led by Robert Westervelt, created a hybrid chip that can control the motion of biological cells; with the chip, researchers can assemble cells one by one into artificial tissue, which can then be used to test the efficacy of various drugs.

This year also brought us several steps closer to nanotube computing, as many research groups developed new ways to custom design nanotubes. Researchers at Stanford University and at Northwestern University came up with two novel ways to sort nanotubes by their electrical properties.

In addition, a group led by James Tour at Rice University developed a revolutionary method first envisioned by the legendary Richard Smalley for growing mass quantities of nanotubes from nanotube "seeds." These methods will find near-term applications in innovative materials, high-definition displays and solar cells, among others.

While many breakthroughs came out of academia, the corporate sector held its own. For instance, **Motorola**'s carbon nanotube TVs are ready to leave the lab and hit the market, outperforming today's flat panel displays and IBM is leading the way to nanoscale computing. From biotech to electronics, it's been an exciting year, and the following breakthroughs are the cream of the crop. So without further ado, we give you the top five nanotech breakthroughs of 2006.

1) DNA ORIGAMI

Researcher: Paul W. K.Rothemund (Caltech)

The sheer simplicity and versatility of Dr. Rothemund's "DNA origami" renders it a revolution in nanoscale architecture. Rothemund developed a technique to fold a single long strand of DNA into any 2D shape held together by a few shorter DNA pieces. He created software to quickly determine what short sequences will fold the main strand into the desired shape, such as the DNA smiley face he built, which is a mere 100nm across and 2nm thick, or his nanoscale map of the Americas.

They sound silly, but these creations are proof of concept: here is a method for building scaffolding that can be used to hold quantum dots in a quantum computer or proteins in a multi-enzyme factory, to name just a few potential applications.

2) NANOMAGNETS TO CLEAN UP DRINKING WATER

Researchers: Vicki Colvin, Amy Kan, William Yu, J.T.Mayo, Arjun Prakash, Joshua

Falkner, Sujin Yean, Lili Cong and Heather Shipley (Rice University)

According to the World Bank, nearly 65 million people are at risk from arsenic-related health problems due to millions of contaminated wells, especially in developing nations like India and Bangladesh. Now, a research team led by Vicki Colvin at Rice University has developed a simple and inexpensive way to solve the problem.

Rust nanoparticles, which have magnetic properties, bind to arsenic; the rust and arsenic can then be lifted out of the water by nothing more than a handheld magnet. The breakthrough was the realization that the manipulation of nanoscale rust would not require huge magnetic fields, as was expected. The unique properties at the nanoscale cause the rust nanoparticles to act as one large magnet that can be easily drawn out of the water, leaving behind drinking water pure enough to meet Environmental Protection Agency standards. The method, which requires no electricity or extensive hardware, will have a global impact.

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3) ARRAYS CONNECT NANOWIRE TRANSISTORS WITH NEURONS

Researchers: Charles Lieber, Fernando Patolsky, Brian Timko, Guihua Yu, Ying Fang, Andrew Greytak, and Gengfeng Zheng (Harvard University)

In the first ever two-way interface between nanoelectronics and living neurons, Dr. Lieber and his team have created a revolutionary way to study brain activity. Silicon nanowires link up with the axons and dendrites of live mammalian neurons, creating artificial synapses between the two and allowing scientists to study and manipulate signal propagation in neural networks.

The device can measure the brain's electric signals with unprecedented sensitivity, amplifying signals from up to 50 places on a single neuron. It will allow researchers to accurately model complex brain activity, pave the way for powerful neural prosthetics, and open the possibility for hybrid nanoelectronic and biological information processing.

4) SINGLE NANOTUBE ELECTRICAL CIRCUITS

Researchers: Phaedon Avouris, Zhihong Chen, Joerg Appenzeller, Yu-Ming Lin, Paul Solomon (IBM's T.J.Watson Research Center); Jennifer Sippel-Oakley and Andrew Rinzler (University of Florida); Jinyao Tang and Shalom Wind (Columbia University)

This year, IBM unveiled the most complex and highest performance electrical circuit based on a single nanotube, demonstrating the applicability of CMOS technology and paving the way for the future of computing.

The integrated logic circuit consists of 12 transistors made of palladium and aluminum tracing the length of a single carbon nanotube. The circuit is hundreds of times slower than today's silicon processors, but it is 100,000 times faster than any previous carbon nanotube device and has the potential to be much faster. Unlike silicon, it doesn't require doping, which scatters electron flow and is far more heat efficient. Expect to first see these nanotube circuits in hybrid nanotube-silicon computers.

5) NANOPARTICLES DESTROY PROSTATE CANCER

Researchers: Robert Langer (MIT); Omid Farokhzad, Benjamin Teply, Ines Sherifi, Jerome Richie (BWH and Harvard); Jianjun Cheng (U.of Illinois); Sangyong Jon (Gwangju Institute of Science and Technology, South Korea); Philip Kantoff (Dana Farber Cancer Institute)

Here's one battle with cancer where cancer is losing dramatically--researchers at MIT and Harvard have custom-designed nanoparticles that hone in on prostate cancer cells and deliver doses of targeted chemotherapy.

In trials with mice, which were given human prostate cancer, a single injection of these nanoparticles completely eradicated tumors in five out of seven animals, significantly reducing tumor size in the other two. The work may be replicable for treatments of breast and pancreatic cancer, as well. Look forward to seeing these cancer-killers in human clinical trials.

Looking Ahead To 2007:

What do we have to look forward to in the coming year? We are sure to see more groundbreaking developments in the emerging interface of nanoelectronics and biology. The number of novel nanoparticles for biomedical applications is poised for accelerated growth, and there will be a special emphasis on combination products that can be used for medical imaging and targeted drug delivery, especially for cancer.

As the corporate world continues to go green, environmental nanotech will come to the forefront, with applications in fuel cells, solar energy and hydrogen storage, to name a few. There's a lot looming on the horizon and we will keep you several steps ahead of the game on the pages of this newsletter. Here's to another great year of thinking big about thinking small!

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