VACCINES

To the source

Nat. Biotechnol. **25,** 1159–1164 (2007)

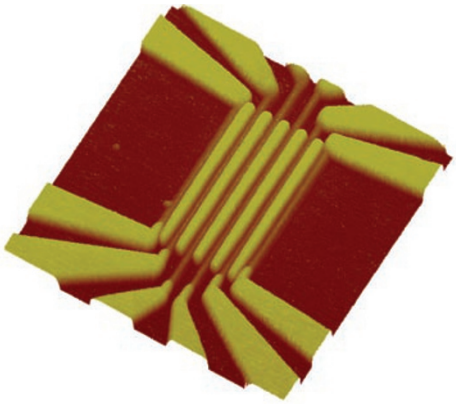
To reach and stimulate the 'dendritic' cells that are part of the immune system, vaccines are often introduced into the skin. However, dendritic cells capable of producing new antigens are most highly concentrated in the lymph nodes. With this in mind, researchers at the Ecole Polytechnique Federale de Lausanne in Switzerland and the Mount Sinai School of Medicine in the US are exploring a nanoparticle-based vaccine delivery method that directly targets the lymph nodes.

To reach their target, the team — led by Melody Swartz and Jeffrey Hubbell — took advantage of a basic biophysical process: the interstitial fluid that naturally flows into the lymphatic system towards the lymph nodes. To pass through the lymphatic capillaries, however, it was essential that the nanoparticles — which consisted of a polypropylene sulphide core and a block copolymer — be no more than a few tens of nanometres in size.

The surface chemistry of the nanoparticles was tailored to stimulate the immune response of the dendritic cells — a key part of the vaccination process. Although the potential toxicity effects of the nanparticles still need to be investigated, the preliminary success of the lymph-node targeting vaccine — and the fact that it is low cost and easy to produce — are incentives to keep studying these nanoparticle vaccines.

NANOWIRE SENSORS

The hottest spot



Nano Lett. **7,** 3106–3111 (2007)

The resistance of semiconductor nanowires depends sensitively on their surface properties, which is why these tiny wires are potentially good detectors of gases or changes in pH. Yet, the vision of arrays of nanowire sensors, each designed to detect a different chemical, faces a challenge: semiconductors are not intrinsically sensitive to any one molecule so each wire must be separately coated with the right chemical linker.

Researchers from the University of California at Berkeley and Hewlett-Packard, both in the US, now show a simple way to do this. The group, led by Inkyu Park and Zhiyong Li, placed a series of silicon nanowires, each 50 nm wide and 50 nm thick, 250 nm apart on an oxidized silicon surface. Electrical contact was made to each nanowire to permit passage of a current and the entire array was coated with a heat-sensitive polymer.

Applying 30 V across one nanowire heats it to above 400 °C — enough to vaporize the polymer coating on the hot wire, but not those nearby. When a chemical linker molecule that can bind to DNA or proteins is deposited on the entire array, only the surface chemistry of the heated (bare) silicon wire is modified. The technique can, in principle, be used with other semiconductors or linker molecules to generate nanowire-based sensor arrays.

MOLECULAR ELECTRONICS

An open-and-shut case

J. Am. Chem. Soc. **129,** 12590–12591 (2007)

The arrangement of chemical bonds in some molecules can be altered with an external stimulus — such as heat, electricity or light — and this change in connectivity can affect their electronic properties. In particular, a class of molecules known as diarylethenes can be switched from an 'open' structure to a 'closed' one in a process that causes the carbon–carbon double bonds to reorganize into a so-called conjugated system in which electrons are delocalized across the molecule.

Now, Xuefeng Guo, Colin Nuckolls and colleagues from Columbia University, New York, USA have measured the conductance of diarylethene molecules by connecting them to single-walled carbon nanotube (SWNT) electrodes. Each device was made by cutting a SWNT with an electron beam to produce a small gap into which a diarylethene molecule — in its open state — could be bonded. The conductance of a device was found to increase when it was irradiated with ultraviolet light, suggesting that the molecular bridge had been switched from the open to the closed form. Only one type of diarylethene molecule tested — containing nitrogen rather than sulphur atoms — could be reversibly switched between the two states.

The precise electrical characteristics of each device depend on whether the electrode is made from a metallic or semiconducting SWNT. Moreover, it is suggested that the high conductance of some devices could be due to multiple diarylethene molecules bridging the gap between the electrodes — a hypothesis supported by pulsed ultraviolet switching that reveals discrete conductance jumps.

TOP DOWN BOTTOM UP

Connecting people

Developing a microfluidic detector for bird flu involved researchers with a diverse range of skills and nationalities.

Although all six authors of a recent *Nature Medicine* paper describing a microfluidic device for detecting the deadly avian flu H5N1 virus worked at institutes run by the A*STAR organization in Singapore, they came from remarkably different backgrounds. Juergen Pipper, Pavel Neuzil, Yi Zhang and Lukas Novak were based at the Institute of Bioengineering and Nanotechnology, whereas Lisa Ng and Masafumi Inoue worked nearby at the Genome Institute of Singapore and the Institute of Cell and Molecular Biology, respectively. The team also had a truly international flavour, comprising researchers from Germany, Japan, Singapore, China and the Czech Republic (*Nature Med.* **13,** 1259–1263; 2007).

Pipper and colleagues developed the surface chemistry and microfluidic environment for the device while Inoue optimized the bioassay, Ng contributed expertise in infectious diseases and Neuzil, an electrical engineer, perfected the fabrication and electronics for the microfluidic chip. They were all brought together when Pipper and Neuzil worked with Winnie Chua of Exploit Technologies — the commercialization arm of A*STAR — to file patents related to their work on microfluidics, and she suggested that they contact Ng and Inoue.

The new lab-on-a-chip device uses an aqueous suspension of tiny magnetic particles to extract viral RNA, transport, mix and then detect the cDNA products amplified in a process known as the polymerase chain reaction. The device is 2,000–5,000% cheaper than commercially available tests, and detection from a throat swab takes less than 28 minutes because it requires only nanolitres of process volumes.

Pipper admits that it was not easy to find a "common language" given the very different backgrounds of all the researchers. "For a successful collaboration," he advises, "you sometimes have to restrain your ego because you will not be able to accomplish your goals alone".

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.