Electric Jolt Triggers Release of Biomolecules, Nanoparticles

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Johns Hopkins researchers have devised a way to use a brief burst of electricity to release biomolecules and nanoparticles from a tiny gold launch pad. The technique could someday be used to dispense small amounts of medicine on command from a chip implanted in the body. The method also may be useful in chemical reactions that require the controlled release of extremely small quantities of a material.

The technique was to be described Sept. 10 in a presentation by Peter C. Searson, a Johns Hopkins professor of materials science and engineering, during the 232nd national meeting of the American Chemical Society in San Francisco. "You can think of the useful biomolecule or nanoparticle as a balloon tethered to a surface," he said. "We use an electrical pulse to cut the tether, and it floats away."

This method could be used to control the release of drug molecules; nanoparticles; biopolymers such as peptides, proteins and DNA; and protein assemblies such as viruses, said Searson, who also is director of the Institute for NanoBioTechnology at Johns Hopkins.

"The technique is relatively simple, but nothing like this has been done before," he said. "Scientists have known that molecules could be removed from a surface in this way, but it's never been considered useful. They've been more interested in preventing this from happening."

Yet Searson and Johns Hopkins biomedical engineering graduate students Prashant Mali and Nirveek Bhattacharjee concluded that this controlled release of molecules might have important applications in the growing field of nanobiotechnology.

For their experiments, the researchers used gold electrodes, each as thin as a single strand of human hair, fabricated through the same photolithography techniques used to make computer chips. "We used a gold electrode because gold is a good conductor of electricity," said Mali, "and because it's an inert metal, it wouldn't get involved in any of the chemical reactions."

To tether each useful molecule to this surface, the team used a long chain of hydrocarbon molecules. At one end, the tether was anchored to the electrode by a gold-sulfur bond. At the other end was the biomolecule they wished to release on command. The researchers then sent a brief, mild pulse of electricity through wires attached to each electrode. The current caused the bond between the sulfur atoms and the gold platform to break, setting free the tethered molecule.

In theory, the researchers said, this technique could be incorporated into a biocompatible implant chip that would release medicine inside a patient on command.

Scientists elsewhere are working on other new drug delivery techniques, such as microfabricated containers that unload their medication inside the body when a lid dissolves. Although it requires further research and development, the Searson team's approach could have several advantages over the container technology. "Because our molecules are attached to a surface, we can work with much smaller concentrations," Searson said. "We've also shown that our system is reusable. After a group of molecules is released, you can easily attach new molecules to an electrode and use it again."

Earlier this year, Searson, Mali and Bhattacharjee reported on their technique in the journal Nano Letters. A patent on the process is pending, and licensing inquiries are being handled by the Johns Hopkins Technology Transfer staff.

Source: Johns Hopkins University

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