Chemical & Engineering News
Serving the chemical, life sciences and laboratory worlds

# Latest News



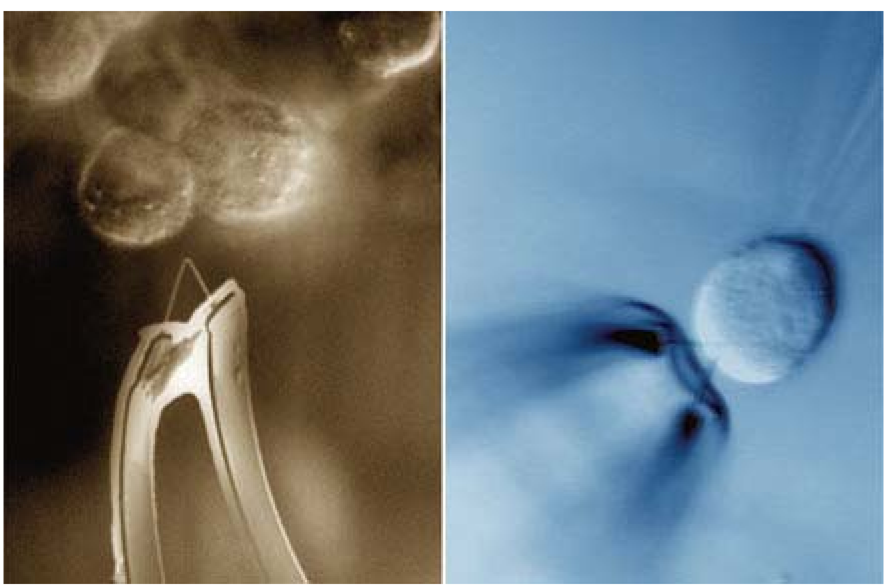


August 13, 2010

# A Wire For Spying On Cells

## Nanotechnology: Tiny bioprobe features a field-effect transistor built from a kinked silicon nanowire

Bethany Halford


*Science* (BOTH)

*A nanoFET just 200 nm long approaches (left) and slides into a cell (right).*

**Tapping into the** inner workings of a cell just got significantly more sophisticated, thanks to a new nanoscale field-effect transistor bioprobe (*Science* **2010,** *329*, 830). Unlike passive patch-clamp devices, which have been the intracellular bioprobe of choice since the 1970s, the new probes—known as nanoFETs—are active, so they can amplify signals and interface with modern computers.

Currently, nanoFETs can monitor electrical signals from neurons firing or cardiac cells driving a beating heart. But they could also be outfitted with a receptor or a ligand to act as biochemical probes to measure the expression of nucleic acids or proteins.

The use of nanoFETs “represents the first totally new approach to intracellular studies in decades, as well as the first measurement of the inside of a cell with a semiconductor device,” says Harvard University chemistry professor Charles M. Lieber, who spearheaded the work. “Our breakthrough allows for the first time the capability to interface directly digital electronics with living cells in a way that literally blurs the distinction between these two information-processing units of life.”

The device’s key component is a silicon nanowire that Lieber’s team coaxed into growing with a kinked shape. In addition to controlling the nanowire’s kinks, Lieber’s lab can modulate the amounts of impurities in the silicon as it grows so that portions of the nanowire adopt metallike properties (*Nat. Nanotechnol.* **2009,** *4*, 824).

Using this technique, the researchers created a nanoFET in which the “arms” of the nanowire that leads to the transistor have metallike properties and can serve as the device’s source and drain. While previous examples of nanoscale FETs were locked down on flat substrates, Lieber’s three-dimensional design allows the nanoFET to escape what he calls “the tyranny of the substrate” so the entire device can slip into a cell.

Lieber tells C&EN that he’s been dreaming of a device like this for a decade. It’s been a recurring doodle in his notebook of ideas, but he kept wondering how he could incorporate two wires into a device that would still be sufficiently small. “When we first discovered the kink, it was immediately clear that we were just about there,” he says.

The nanoFET’s entry into cells is aided by a phospholipid bilayer coating that mimics the cellular membrane and by the probe’s incredibly small size: The nanowire can be as short as 50 nm and its diameter is just 15 nm.

Lieber’s report “opens up an entirely new domain of nanoscience,” comments Ahmed H. Zewail, a professor of chemical physics at Caltech and the 1999 winner of the Nobel Prize in Chemistry.

“By designing and synthesizing 3-D nanoprobes and enabling flexible field-effect transistors through a nanoelectronic device, Lieber has trail blazed a pathway for entering cellular structures to record their potentials with nanoscale resolution,” Zewail says.

“This study presents an outstanding example of interfacing nanotechnology with cellular-level biology,” adds Zhong Lin (ZL) Wang, director of the Center for Nanostructure Characterization at Georgia Tech.

“The information provided will have revolutionary impact on the fundamental understanding of charge transport processes inside cells, at high spatial resolution that is inaccessible using traditional approaches,” Wang says.

Chemical & Engineering News
ISSN 0009-2347