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Tiny nanowire could be next big diagnostic tool for doctors

A tiny nanowire sensor — smaller than the width of a human hair, 1,000 times more sensitive than conventional DNA tests, and capable of producing results in minutes rather than days or weeks — could pave the way for faster, more accurate medical diagnostic tests for countless conditions and may ultimately save lives by allowing earlier disease detection and intervention, Harvard scientists say.

In preliminary laboratory studies demonstrating the capability of the new sensor, the researchers showed that it has the potential to detect the gene for cystic fibrosis more efficiently than conventional tests for the disease. CF is the most common fatal genetic disease among people of European origin.

One of a growing number of promising diagnostic tools that are based on nanotechnology, the silicon sensor represents the first example of direct electrical detection of DNA using nanotechnology, according to the researchers. The sensor and the detection of the CF gene will be described in the Jan. 14 issue of the journal *Nano Letters*, a peer-reviewed publication of the American Chemical Society, the world's largest scientific society.

"This tiny sensor could represent a new future for medical diagnostics," says study leader Charles M. Lieber, Ph.D., a professor of chemistry at Harvard and one of the leading researchers in nanotechnology.

"What one could imagine," says Lieber, "is to go into your doctor's office, give a drop of blood from a pin prick on your finger, and within minutes, find out whether you have a particular virus, a genetic disease, or your risk for different diseases or drug interactions."

With its high sensitivity, the sensor could detect diseases never before possible with conventional tests, he says. And if all goes well in future studies, Lieber predicts that an array of sensors can ultimately be configured to a handheld PDA-type device or small computer, allowing almost instant test results during a doctor's visit or possibly even at home by a patient. It could potentially be used to screen for disease markers in any bodily fluid, including tears, urine and saliva, he says.

The sensor also shows promise for early detection of bioterrorism threats such as viruses, the researcher says.

An experimental version of the technology consists of a thin plate about the size of a small

business card containing the tiny nanowire sensor. A working prototype device suitable for testing of human blood or other body fluids could be five years away, Lieber estimates.

To demonstrate the effectiveness of the sensor device, the researchers grafted nucleic acids, the building blocks of DNA, to a silicon nanowire. The nucleic acids were specifically designed to recognize a particular mutation site in the cystic fibrosis gene that is responsible for most fatal cases of the genetic disease. The researchers then exposed the nanowire to fragments of the cystic fibrosis gene, some with the lethal mutation and some without it.

The researchers found that they could successfully distinguish between the two types of gene fragments, even down to extremely low levels that would have been missed by conventional DNA sensors, according to Lieber.

Unlike conventional DNA detection methods that require a complex procedure called PCR amplification to view the results, the nanowire sensor does not need such sophisticated and expensive techniques, which could ultimately speed up genetic testing while reducing costs.

Lieber recently helped start a company, NanoSys, Inc., that is now developing nanowire technology and other nanotechnology products. His associate in this study is Jong-in Hahm, Ph. D., a former postdoctoral fellow in his research group who is currently an assistant professor at Penn State University.

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— Mark T. Sampson

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The online version of the research paper cited above was initially published Dec. 9 on the journal's Web site. Journalists can arrange access to this site by sending an e-mail to newsroom@acs.org or calling the contact person for this release.

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