Nanowires spot cancer markers in blood

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Scientists at Harvard University, US, have used arrays of silicon nanowires to detect low levels of molecular markers for cancer in body fluids.

“This is one of the first applications of nanotechnology to healthcare and offers a clinical technique that is significantly better than what exists today,” said Charles Lieber of Harvard University. “A nanowire array can test a mere pinprick of blood in just minutes, providing a nearly instantaneous scan for many different cancer markers. It’s a device that could open up substantial new possibilities in the diagnosis of cancer and other complex diseases.”

The devices contain silicon nanowire field-effect transistors, incorporating both p- and n-type nanowires. Attached to the nanowires are monoclonal antibodies that act as receptors for cancer marker proteins. When a marker protein attaches to an antibody it changes the conductance of the nanowire according to the protein’s surface charge and the doping of the wire.

For example, a protein with a negative surface charge will increase the conductance of a p-type silicon nanowire but reduce the conductance of an n-type wire. The presence of both p- and n-type wires helps to prevent false positive results.

The researchers made devices that were detected the protein markers prostate-specific antigen (PSA), PSA-α1-antichymotrypsin, carcinoembryonic antigen and mucin-1. Doctors generally look for the presence of PSA and PSA-α1-antichymotrypsin to diagnose prostate cancer. Each nanowire sensor chip contained about 200 individually addressable devices, as well as a microfluidic channel for introducing the sample.

“Our results show that these devices are able to distinguish between molecules with near-perfect selectivity,” said Lieber.

The devices detected concentrations of 0.9 pg/ml in undiluted serum samples. The researchers believe their technique has the advantages of high sensitivity, the ability to test for several different markers simultaneously, and the provision of real-time testing without the use of labelling.

Lieber and colleagues also customized their devices to detect telomerase, a ribonucleoprotein complex found to be active in at least 80% of all known human cancers. To do this, they functionalized silicon nanowires with oligonucleotide primers complementary to the telomerase binding site. Introducing a cell extract containing telomerase decreased the conductance of p-type nanowires as telomerase is positively charged. The scientists say they could measure telomerase binding and activity down to a ten-cell level without amplification.

The researchers reported their work in *Nature Biotechnology*.

About the author

Author

Liz Kalaugher