Ultrasensitive biosensor can detect proteins, aid in cancer diagnosis

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Researchers at Boston College discovered that a cluster of carbon nanotubes coated with a thin layer of protein-recognizing polymer forms a biosensor capable of using electrochemical signals to detect minute amounts of proteins. This new biosensor could provide a crucial new diagnostic tool for the detection of cancer and other illnesses.

The nanotube biosensor, described by Thomas Chiles and his colleagues in a paper published in the journal *Nature Nanotechnology*, proved capable of detecting human ferritin, the primary iron-storing protein of cells, and E7 oncoprotein derived from human papillomavirus. Further tests using calmodulin showed the sensor could discriminate between varieties of the protein that take different shapes, according to the multi-disciplinary team of biologists, chemists, and physicists that developed the sensor.

Molecular imprinting techniques have shown that polymer structures can be used in the development of sensors capable of recognizing certain organic compounds, but recognizing proteins has presented a difficult set of challenges. Dr. Chiles' team used arrays of wire-like nanotubes coated with a non-conducting polymer coating capable of recognizing proteins with subpicogram per liter sensitivity.

Central to the function of the sensor are imprints of the protein molecules within the non-conducting polymer coating. Because the imprints reduce the thickness of the coating, these regions of the polymer register a lower level of impedance than the rest of the polymer

insulator when contacted by the charges inherent to the proteins and an ionized saline solution. When a protein molecule drops into its mirror image, it fills the void in the insulator, allowing the nanotubes to register a corresponding change in impedance, signaling the presence of the protein.

Binding can be read in real time, instead of after days or weeks of laboratory analysis, meaning the nanotube molecular imprinting technique could pave the way for biosensors capable of detecting human papillomavirus or other viruses weeks sooner than available diagnostic techniques currently allow. As opposed to searching for the HPV antibody or cell-mediated immune responses after initial infection, the nanotube sensor can track the HPV protein directly. In addition, no chemical marker is required by the label-free electrochemical detection methods.

This work is detailed in a paper titled, "A molecular-imprint nanosensor for ultrasensitive detection of proteins." An abstract of this paper is available at the journal's Web site.

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