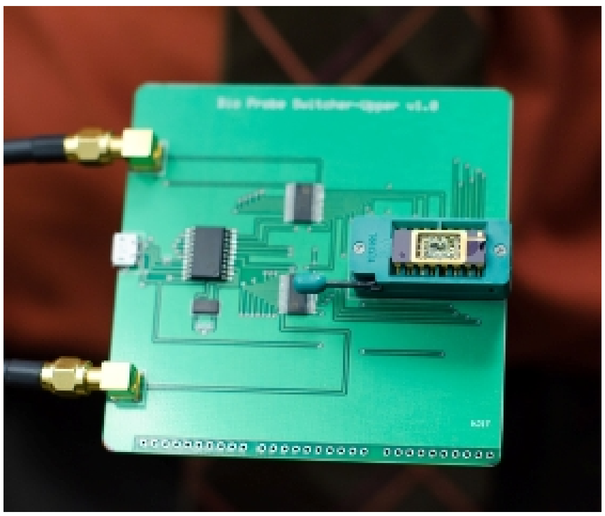
Research shows promise of new device to detect disease with drop of blood

June 24 2013



This prototype lab-on-a-chip would someday enable a physician to detect disease or virus from just one drop of liquid, including blood.

(Phys.org) —An NJIT research professor known for his cutting-edge work with carbon nanotubes is overseeing the manufacture of a prototype lab-on-a-chip that would someday enable a physician to detect disease or virus from just one drop of liquid, including blood. "Scalable nano-bioprobes with sub-cellular resolution for cell detection," *Biosensors and Bioelectronics*, which will publish on July 15, 2013 but is available now online, describes how NJIT research professors Reginald Farrow and Alokik Kanwal, his former postdoctoral fellow, and their team have created a carbon nanotube-based device to noninvasively and quickly detect mobile single cells with the potential to maintain a high degree of spatial resolution.

"Using sensors, we created a device that will allow medical personnel to put a tiny drop of liquid on the active area of the device and measure the cells' electrical properties," said Farrow, the recipient of NJIT's highest research honor, the NJIT Board of Overseers Excellence in Research Prize and Medal. "Although we are not the only people by any means doing this kind of work, what we think is unique is how we measure the electrical properties or patterns of cells and how those properties differ between cell types."
In the article, the NJIT researchers evaluated three different types of cells using three different electrical probes. "It was an exploratory study and we don't want to say that we have a signature," Farrow added. "What we do say here is that these cells differ based on electrical properties. Establishing a signature, however, will take time, although we know that the distribution of electrical charges in a healthy cell changes markedly when it becomes sick."

This research was originally funded by the military as a means to identify biological warfare agents. However, Farrow believes that usage can go much further and potentially detect viruses, bacteria, even cancer. The research may also someday even assess the health of good cells, such as brain neurons. Since 2010, three U.S. patents, "Method of forming nanotube vertical field effect transistor," #7,736,979 (2010); "Nanotube device and method of fabrication" #7,964,143 (2011); "Nanotube device and method of fabrication" #8,257,566 (2012) were awarded for this device. In addition, more patents have been filed.

The device (shown in photo) utilizes standard complementary metal oxide semiconductor (CMOS) technologies for fabrication, allowing it to be easily scalable (down to a few nanometers). Nanotubes are deposited using electrophoresis after fabrication in order to maintain CMOS compatibility.

The devices are spaced by six microns which is the same size or smaller than a single cell. To demonstrate its capability to detect cells, the researchers performed impedance spectroscopy on mobile human embryonic kidney (HEK) cells, neurons from mice, and yeast cells. Measurements were performed with and without cells and with and without nanotubes. Nanotubes were found to be crucial to successfully detect the presence of cells.

Carbon nanotubes are very strong, electrically conductive structures a single nanometer in diameter. That's one-billionth of a meter, or approximately ten hydrogen atoms in a row. Farrow's breakthrough is a controlled method for firmly bonding one of these submicroscopic, crystalline electrical wires to a specific location on a substrate. His method also introduces the option of simultaneously bonding an array of millions of nanotubes and efficiently manufacturing many devices at the same time.

Being able to position single carbon nanotubes that have specific properties opens the door to further significant advances. Other possibilities include an artificial pancreas, three-dimensional electronic circuits and nanoscale fuel cells with unparalleled energy density.

More information: www.sciencedirect.com/science/ … ii/S0956566313000961

Provided by New Jersey Institute of Technology