Carbon Nanotube Network Detects DNA Without Labels

February 3 2006

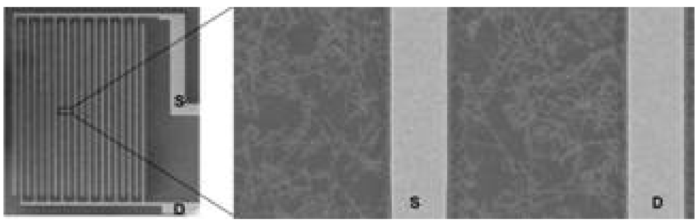

Figure 1: A random network of carbon nanotubes lies between parallel metal electrodes on a silicon chip. The distance between the electrodes is 10 micrometers.

Using a microchip device constructed with carbon nanotubes, researchers at the University of Pittsburgh and Nanomix, Inc., in Emeryville, CA, have developed a rapid method of detecting specific DNA sequences, including single-base mutations. The sensitivity of the new device is good enough to detect a single-base mutation in an amount of DNA present in one milliliter of blood.

This work was reported in the *Proceedings of the National Academy of Science USA*.

The key element of the new device is a network of carbon nanotube field-effect transistors. A team of investigators led by Alexander Star, Ph.D., from the University of Pittsburgh, and Christian Valcke, Ph.D., of Nanomix, Inc., created this sensing element by depositing single-wall carbon nanotubes between sets of parallel electrodes etched into a standard semiconductor chip (see Figure 1). Rather than attempt to align a few carbon nanotubes between a set of electrodes, a task that has proven difficult, the investigators used a large, random network of nanotubes.

The flow of electrical current between the two electrodes depends on the average electrical conductivity of the nanotube network lying between them. In turn, the electrical conductivity of the nanotube network changes markedly whenever DNA molecules stick to the surface of an individual nanotube.

To make the device specific for a particular piece of DNA, the investigators first coat the nanotubes with a piece of DNA whose sequence is complementary to the sequence of interest. If the goal is to detect a particular gene mutation, for example, the nanotubes would be coated with DNA whose base sequence (the order or A, T, C, and G) is complementary to that of a stretch of DNA that includes the known mutation. When a sample of DNA is then added to the device, any piece of DNA containing the target sequence, in this case a particular mutation, binds its complement on the nanotubes, producing a sharp drop in electrical conductivity.

The researchers note that their use of a random network of carbon nanotubes should make it easy to manufacture these devices at a low cost. The investigators are now working on methods for incorporating these sensors into microfluidics devices that could be used in doctors' offices.

This work is detailed in a paper titled, “Label-free detection of DNA hybridization using carbon nanotube network field-effect transistors.” Investigators from the University of Pittsburgh and the University of California, Los Angeles, also participated in this study. An abstract is available through PubMed.

Source: National Cancer Institute