Aluminum-oxide nanopore beats other materials for DNA analysis

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Fast and affordable genome sequencing has moved a step closer with a new solid-state nanopore sensor being developed by researchers at the University of Illinois.

The nanopore sensor, made by drilling a tiny hole through a thin film of aluminum oxide, could ultimately prove capable of performing DNA analysis with a single molecule, offering tremendous possibilities for personalized medicine and advanced diagnostics.

"Solid-state nanopore sensors have shown superior chemical, thermal and mechanical stability over their biological counterparts, and can be fabricated using conventional semiconductor processes," said Rashid Bashir, a Bliss Professor of electrical and computer engineering and bioengineering, and the director of the university's Micro and Nanotechnology Laboratory.

"The aluminum-oxide nanopore sensors go a step further," Bashir said, "exhibiting superior mechanical properties, enhanced noise performance and increased lifetime over their silicon-oxide and silicon-nitride counterparts."

The researchers describe the fabrication and operation of the aluminum-oxide nanopore sensor in a paper accepted for publication in *Advanced Materials*, and posted on the journal's Web site.

To make the sensor, the researchers begin by using a technique called atomic layer deposition to produce a very thin film of aluminum oxide on a silicon substrate.

Next, the central portion of the substrate is etched away, leaving the film as a suspended membrane. An electron beam is then used to create a very tiny hole - a nanopore - in the membrane.

The process of making the nanopore resulted in an unexpected bonus, Bashir said. "As the electron beam forms the nanopore, it also heats the surrounding material, forming nanocrystallites around the nanopore. These crystals help to improve the mechanical integrity of the nanopore structure and could potentially improve noise performance as well."

The nanopore sensors described in the paper had pore diameters ranging in size from 4 to 16 nanometers, and a film thickness of approximately 50 nanometers. Thinner membranes are possible with atomic layer deposition, Bashir said, and would offer higher resolution of the detection.

"Thinner membranes can produce less noise as a molecule travels through the nanopore," said Bashir, who is also affiliated with the university's Beckman Institute, the Frederick Seitz Materials Research Laboratory, and the Institute for Genomic Biology. "Ultimately, we'd like to make our membranes as thin as biological membranes, which are about 5 nanometers thick."

To demonstrate the functionality of the aluminum-oxide nanopores, the researchers performed experiments with pieces of DNA containing approximately 5,000 base pairs. Bashir's team verified the detection of single molecules, with a signal-to-noise performance comparable to that achieved with other solid-state nanopore technology.

"More work must be done to achieve single base resolution, however," Bashir said. "Our next step is to detect and measure significantly shorter molecules."

Source: University of Illinois at Urbana-Champaign (news : web)

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