DNA through graphene nanopores

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A team of researchers from Delft University of Technology (The Netherlands) announces a new type of nanopore devices that may significantly impact the way we screen DNA molecules, for example to read off their sequence. In a paper entitled 'DNA Translocation through Graphene Nanopores' (published online in *Nano Letters*), they report a novel technique to fabricate tiny holes in a layer of graphene and they managed to detect the motion of individual DNA molecules that travel through such a hole.

There is a worldwide race to develop fast and low-cost strategies to sequence DNA, that is, to read off the content of our genome. Particularly promising for the next generation of sequencing are devices where one measures on single molecules. Imagine a single DNA molecule from one of your cells (3 billion bases, 1 meter long if you would stretch it from head to tail) that is read - base per base - in real time while sliding between two of your fingers. This is what postdoc dr. Gregory Schneider in the group of professor Cees Dekker and colleagues from the Kavli Institute of Nanoscience have in mind. They now demonstrated a first step in that direction: To slide a single molecule of DNA through a tiny nanoscale hole made in the thinnest membrane that nature can offer, a 1-atom thin layer of graphene.

Graphene is a unique and very special material, and yet widely available: Everyone has graphene at home: graphite is made of layers of graphene and occurs in for example the carbon of pencils, charcoal, or candle soot. But in this research, graphene is used because of that special property that one can make single-atom-thin monolayers of graphene. Why is such an ultrathin membrane important? Let's go back to that wire sliding between your fingers. The distance between two bases in DNA is very small, about half a nanometer, which is 100000 times smaller than the width of a human hair! To read off each base along the DNA, one therefore needs a recorder that is smaller than that half nanometer. If your fingers can be scaled down to that size, you are in business. And here's where these atomically thin graphene membranes are crucial.

What Schneider and coworkers did was to fabricate a nanometer-scale hole - called a nanopore - in the graphene membrane, which represents the ideal recorder. They demonstrated that single molecules of DNA in water can be pulled through such a graphene nanopore and, importantly, that each DNA molecule can be detected as it passes through the pore. The detection technique is very simple: upon applying an electrical voltage across the nanopore, ions in the solution start to flow through the hole and a current is detected. This current gets smaller whenever a DNA molecule enters the nanopore and partly blocks the flow of ions. Each single DNA molecule that slides through the pore is thus detected by a drop in the current.

The DNA moves base per base through the nanopore. With the atomically thin graphene nanopore one in principle has the potential for reading off the DNA sequence, base per base. A number of groups worldwide have been trying to realize graphene nanopores. Schneider et al are the first to report their results this week.

DNA translocation through nanopores has been developed before by the Dekker lab and others, for example using SiN membranes. Graphene nanopores offer new opportunities - many more than sequencing. Since graphene, unlike SiN, is an excellent conductor, an obvious next step is using the intrinsic conductive properties of graphene. Nanopores offer a range of opportunities of sensors for science and applications.

Provided by Delft University of Technology