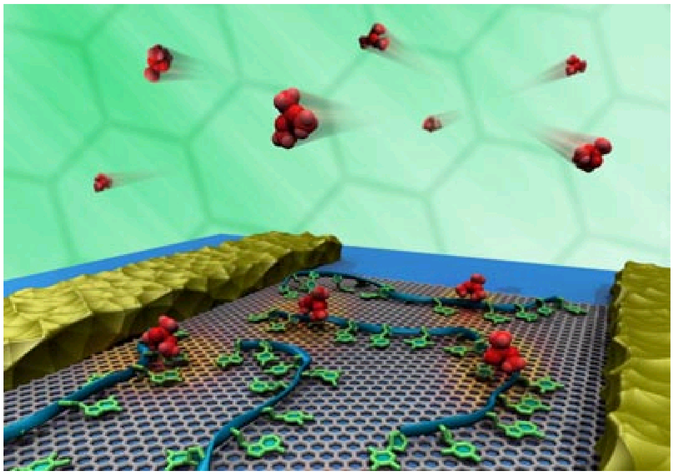
News archive

- 2010
  - December 2010
  - November 2010
  - October 2010
  - September 2010
  - August 2010
  - July 2010
  - June 2010
  - May 2010
  - April 2010
  - March 2010
  - February 2010
  - January 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002
- 2001
- 2000
- 1999
- 1998
- 1997

DNA helps turn graphene into a chemical sensor

Aug 31, 2010   1 comment



DNA-decorated graphene sensor

A new chemical sensor based on just two materials, graphene and DNA, has been unveiled by researchers in the US. The device is simple, highly sensitive and easy to make and the scientists believe that it could be used to make an electronic "nose" capable of sensing a variety of molecules. Eventually, such sensors could be used in hospitals to detect disease, at security checkpoints to pinpoint dangerous chemicals and even by rescue teams to find lost people.

Like their biological counterparts, electronic noses are sensitive to a large number of different molecules. To achieve this, they usually consist of hundreds, or even thousands, of sensors on the same chip. Each sensor reacts to a specific molecule, just like the olfactory receptor proteins in mammal noses do. However, the need to fabricate thousands of different sensors – and the challenges of converting chemical reactions into electronic signals – can make electronic noses expensive and complicated devices.

Now, A T Charlie Johnson of the University of Pennsylvania and colleagues Ye Lu, Brett Goldsmith and Nick Kybert have come up with a simple way of sensing chemicals by showing that the electronic properties of DNA-coated graphene change in when exposed to certain molecules.

Begin with graphene transistors

Graphene is a sheet of carbon just one atom thick and the team based its devices on graphene transistors made using the standard "sticky tape" method, which involves exfoliating individual atomic layers of carbon from graphite. Next, the researchers thoroughly cleaned the graphene to remove any residue on the surface that can cause unwanted signals.

Each transistor was then soaked in a solution of a specific sequence of single-stranded DNA, which self-assembles into a pattern on the surface of the graphene. DNA is made from four different bases – adenine (A); cytosine (C), thymine (T); and guanine (G) – and an example of a sequence used is GAG TCT GTG GAG GAG GTA GTC. "We only tested a few sequences but the number of possible

Sign up

To enjoy free access to all high-quality "In depth" content, including topical features, reviews and opinion sign up

Share this

E-mail to a friend
Twitter
Facebook
Connotea
CiteULike
SHARE

Related stories

Nanotubes make miniature gas sensors
Graphene could revolutionize DNA sequencing

Related links

Johnson Research Group
arxiv.org/abs/1008.3540

Restricted links

Appl. Phys. Lett. **97** 083107

sequences is essentially endless," explained Johnson.

The researchers selected their DNA sequences based on the ability of the sequence to work as a chemical sensitizing agent – a role very different from the function of DNA in living organisms. Each sequence behaves a little differently on the surface of graphene because it has a different shape, pH and hydrophilic properties. This means that every sequence interacts differently with different volatile organic chemicals (VOCs).

Change in resistance

When the DNA/graphene reacts with a chemical in its environment, the resistance of graphene changes. This change, which can be as large as 50%, can easily be measured using simple equipment. And, because this is a direct electronic measurement, it is very fast – complete responses can be seen in less than 10 seconds and the sensors recovers in about 30.

"By making an array of such DNA-graphene devices, we believe that we could exploit this property of DNA/graphene to detect explosives, chemical weapons (like nerve gas agents) or even toxic compounds that might be accidentally released at a plant," Johnson told *physicsworld.com*.

"One of the great things about this research is that there is nothing really expensive about any of the sensor components, given the continual advances being made in graphene production," said Johnson.

Putting dogs out of business

The team's next big challenge is to scale up production of its sensors. "We need to test more DNA sequences, fit more devices on a chip and make sure we understand all the signals when a big array of sensors is exposed to a mixture of chemicals," adds Johnson. "We have high hopes for these sensors but there are still lots of hurdles to overcome. Eventually, we would like to put dogs out of the chemical sensing business, and with proper development, sensors like ours might be able to do that."

The research paper describing this work can be seen for free on *arXiv*. It has also just been published in *Applied Physics Letters*.

About the author
Belle Dumé is a contributing editor to *nanotechweb*

1 comment
Comments on this article are now closed.

1 **reader01**
Sep 3, 2010 4:05 PM

again glamorous graphen

That is very clever to use 4 base of DNA and graphen to gain new wide range substance sensor.

Offensive? Unsuitable? Notify Editor