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MEDICAL APPLICATIONS

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Medical Applications Play to Graphene's Strengths

In the first decade since graphene was first produced in the lab, much of the research around it has been focused on its potential for electronic applications. The truth is that future of graphene in electronics is a bit of a mixed bag. Since it lacks an inherent band gap, it doesn't look as promising as some other two-dimensional materials in leading to a replacement for silicon in digital logic applications.

As a result, we have begun to see more research around graphene aimed at exploiting its strengths rather than overcome its weaknesses, i.e. engineering a band gap into it.

In addition to graphene's high conductivity, which allows electrons to travel through it much faster than other materials, graphene is extremely flexible. This has made it very attractive for those working with flexible electronics to see how it might be used in these applications.

Graphene-Enabled Elastic Bands Could Have an Impact in Health Monitoring

Photo: Getty Images

Now researchers at the University of Surrey in the UK and Trinity College in Ireland may have found another use for that flexibility—adding graphene to rubber bands to give elastics electronic properties and using the combination for health monitoring.

The research, which was published in the journal ACS Nano, developed a simple process for infusing graphene into elastic bands providing them with the electrical properties that makes them into essentially strain sensors. This means that the graphene-enabled elastic bands could be used as wearable sensors to monitor a patient's breathing, heart rate, or irregular movements.

"Until now, no such sensor has been produced that meets these needs," said Surrey's Dr. Alan Dalton, in a press release. "It sounds like a simple concept, but our graphene-infused rubber bands could really help to revolutionize remote healthcare—and they're very cheap to manufacture."

Professor Jonathan Coleman from Trinity College, Dublin added: "This stretchy material senses motion such as breathing, pulse and joint movement and could be used to create lightweight sensor suits for vulnerable patients such as premature babies, making it possible to remotely monitor their subtle movements and alert a doctor to any worrying behaviors."

Graphene for Wearable Sensors

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Researchers at the University of Michigan have developed a graphene-based wearable sensor capable of detecting airborne chemicals that act as indicators of medical conditions. So the wearable sensor could detect diabetes by detecting the chemical acetone, which is a biomarker for diabetes.

"With our platform technology, we can measure a variety of chemicals at the same time, or modify the device to target specific chemicals. There are limitless possibilities," said Zhaohui Zhong, an associate professor at the University of Michigan, in a press release.

The research, which was published in the journal *Nature Communications*, is a departure from other nanosensor detection techniques. While most other nanosensors are based on detecting a change in charge density due to a molecule binding to the sensor, this graphene-based sensor is based on detecting molecular dipoles.

"Nanoelectronic sensors typically depend on detecting charge transfer between the sensor and a molecule in air or in solution," said Girish Kulkarni, a doctoral candidate and one of the researchers, in a press release. "Instead of detecting molecular charge, we use a technique called heterodyne mixing, in which we look at the interaction between the dipoles associated with these molecules and the nanosensor at high frequencies."
The graphene is the key to the extremely fast response rates of the sensor, which were clocked at tenths of a second as opposed to tens or hundreds of seconds in existing technology.

The researchers have been able to build a prototype detection system that serves as an entire chromatography system on a single chip. In future iterations of the device, a patient could wear a badge-side (?SIZED?) device to provide continuous monitoring of health conditions.

Graphene Enables Both Disease Detection and Drug Delivery

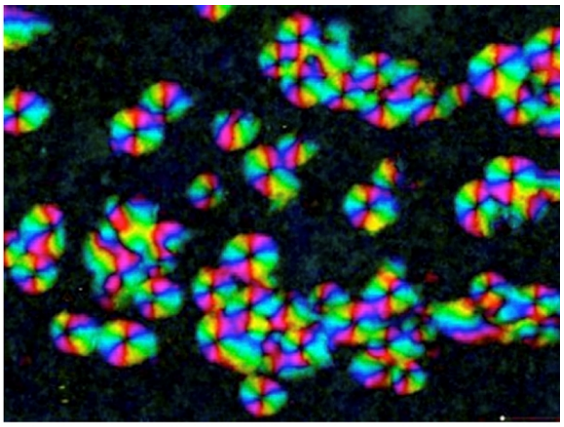

Image: Monash University

Graphene-infused elastic bands are relatively simple to produce, but graphene has also been investigated for medical applications in far more complex technologies, such as gene sequencing. Along these lines, researchers at Monash University in Melbourne, Australia have made a serendipitous discovery about graphene oxide that could lead to the material's use in disease detection and drug delivery.

What the researchers discovered was that when graphene oxide is exposed to a certain pH level it transforms into liquid crystal droplets. This could make considerably easier the process of making graphene into a spherical form, which previously required atomizers and other mechanical equipment.

“To be able to spontaneously change the structure of graphene from single sheets to a spherical assembly is hugely significant. No one thought that was possible. We’ve proved it is,” said Monash's Rachel Tkacz in a press release. “Now we know that graphene-based assemblies can spontaneously change shape under certain conditions, we can apply this knowledge to see if it changes when exposed to toxins, potentially paving the way for new methods of disease detection.”

In addition to disease detection, the researchers have also considered that this the spontaneous transformation of graphene oxide into liquid crystal droplets could lead to a drug delivery method.

“Drug delivery systems tend to use magnetic particles which are very effective but they can’t always be used because these particles can be toxic in certain physiological conditions,” said Mainak Majumder, one of the researchers, in the release. “In contrast, graphene doesn’t contain any magnetic properties. This combined with the fact that we have proved it can be changed into liquid crystal simply and cheaply, strengthens the prospect that it may one day be used for a new kind of drug delivery system."