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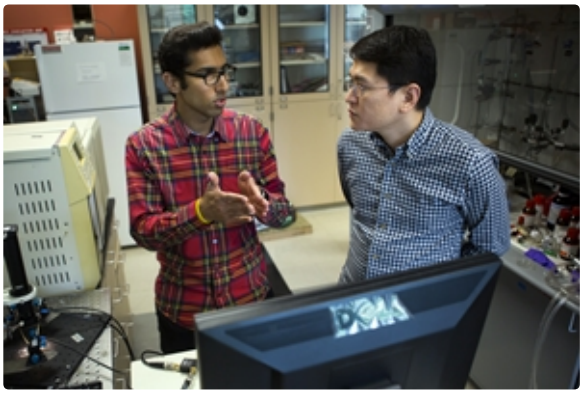
Graphene Sensor Designed for Wearable Disease Detection

BY ALAN, ON AUGUST 7TH, 2014



First author Girish Kulkarni, left, and Zhaohui Zhong testing the graphene sensor (Joseph Xu, University of Michigan)

7 August 2014. Engineers at **University of Michigan** in Ann Arbor designed a sensor from graphene that makes it possible to embed the technology into wearable devices for disease detection. The team from the labs of electrical engineering professor **Zhaohui Zhong** and biomedical engineering professor **Sherman Fan** published their results last month in the journal ***Nature Communications*** (paid subscription required).

The Michigan team is aiming at a market for wearable technologies that is expected to grow to $70 billion by 2024, according to market analysis company **IDTechEx**. The university filed a provision patent on the technology and the researchers are taking part in **Innovation Corps**, a National Science Foundation program to help academic scientists become entrepreneurs and turn their discoveries into marketable goods and services. In June, NSF extended the Innovation Corps program to **National Institutes of Health** to move more biomedical discoveries into the marketplace.

Zhong, Fan, and colleagues designed the sensor to detect chemical indicators of disease, exhaled or emitted through the skin. Current nano-electronic sensors for this purpose detect a change in the electric charge between the molecules being detected and the sensor. With today's technology, say the researchers, the molecules being detected develop a strong bond with the sensor, which slows the sensor's action and requires a higher concentration in the air or solution.

The Michigan technology takes a different approach. The researchers adapted a process known as **heterodyne mixing** that interacts two or more signals to generate a new frequency. In this case, the sensor detects the interaction of imbalances in polarity among the chemical molecules, called **molecular dipole moments**. With **graphene** in the sensor, the team used a material related to graphite, consisting of a single atomic layer of carbon atoms arrayed in a hexagonal mesh pattern that's light, strong, chemically stable, and can conduct both heat and electricity.

The researchers report the sensor detects various chemical vapors in the lab that can serve as indicators of disease, such as **acetone** for the detection of diabetes, and **nitric oxide** to detect asthma. In addition, the sensor detects test substances in tenths of a second, much faster than current technology, and in concentrations measured in a few parts per billion.

The team says the technology would be part of a miniature **gas chromatography** system that integrates the graphene sensors in a single low-power chip, embedded in a badge-sized device worn on the body. The device could also be applied to sensing the presence of dangerous chemicals or monitoring environmental air quality.

"With our platform technology, we can measure a variety of chemicals at the same time, or modify the device to target specific chemicals," says Zhong in a university statement. "There are limitless possibilities."

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