Disposable, ultrafast optical humidity sensors provide better moisture control for manufacturing and storage

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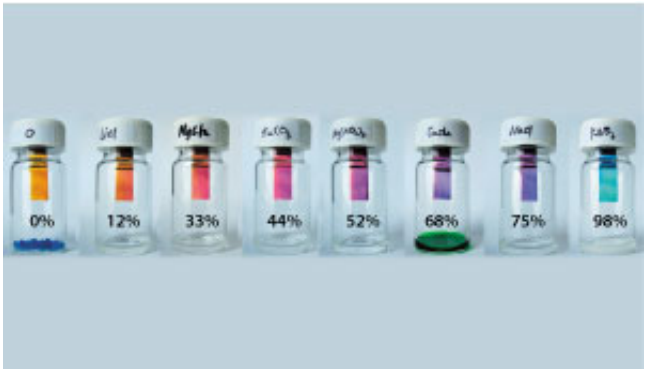

Response of graphene oxide sensor to increased humidity levels. Credit: American Chemical Society

A*STAR researchers have designed a low-cost, stable and ultrafast responsive sensor that is easy to manufacture, overcoming the challenge of producing a simple, fast and highly sensitive version.

Fuke Wang and colleagues from the Singapore Institute of Materials Research and Engineering, A*STAR have developed an optical humidity sensor that exploits the unique properties of ultrathin layers of graphene oxide (GO) films.

The humidity levels of ambient air can have a significant effect on

human comfort and health; it can impact many manufacturing processes and is detrimental to the quality of stored goods. The ability to monitor and control humidity levels with accurate and reliable humidity sensors is essential for efficient manufacturing and storage practices as well as wellbeing.

"Our research shows for the first time that atomic-scale GO can be used for colorimetric humidity sensors," says Wang. "Due to the atomic properties of GO and their hygroscopic nature, the sensor is highly efficient and faster-responding compared with current sensor technologies."

Unlike most humidity sensors, which are electronic and require a power supply, GO-based colorimetric sensors respond to humidity levels by changing color that can be easily observed (see image). For greater accuracy, the change in color can be quantitatively measured by analyzing the reflection spectra of the sensor. Because the GO sensor operates at the atomic level, it can rapidly respond to moisture changes.

Exploiting the atomic properties of GOs can only occur if films of uniform thickness can be fabricated; thickness influences the response time and uniformity determines the quality of the sensor.

The research team overcame this challenge by using a process, in which a substrate is dipped in and out of a solution at a constant speed.

"We focused on optimizing the solution viscosity, the substrate-surface treatment and the dip-coating conditions," explains Wang, "this showed that we can now easily control the thickness of uniform films of GO with a process that is scalable and also generates zero waste."

The low-cost, non-toxicity and rapid response of GO sensors makes them ideal as disposable sensors. They can be incorporated into food

packaging, where humidity levels need to be strictly controlled for storage, for medical instrumentation and semiconducting device manufacturing and storage, as well as environmental monitoring. Their disposal also has no environmental impact.

"We are now exploring further increases in efficiency and sensitivity, and the application to other vapors and gases," says Wang.

More information: Hong Chi et al. Highly Sensitive and Fast Response Colorimetric Humidity Sensors Based on Graphene Oxides Film, *ACS Applied Materials & Interfaces* (2015). DOI: 10.1021/acsami.5b06883

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